

**OPERATION  
AND  
MAINTENANCE  
MANUAL**

**NAV-40IL**





# NAV-401L

MARKER, G/S, VOR, LOC, COMM, RAMP AND BENCH TEST SET



Manual Part Number: 1002-0972-600

10200 WEST YORK STREET/WICHITA, KANSAS 67215 U.S.A./(316) 522-4981 TWX 910-741-6952

1100-VAN

PUBLISHED BY  
IFR SYSTEMS, INC.  
Wichita, Kansas

Copyright © 1988 by IFR SYSTEMS, INC.

All rights reserved. Printed in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.

# CAUTION

- Most COMM receiver antenna connectors are also used for the COMM transmitter connector. Precautions should be taken not to key the transmitter with the COMM antenna connector connected to the NAV-401L/402AP RF Output Connector. Transmitter output signals at this connector may cause damage to the Attenuator and Signal Generator System.
- Do not key transmitter into the Modulation Input/ External Frequency Counter Input Connector, the RF Output Connector, or the connectors on the Rear Panel. Internal damage may result.
- Do not exceed 100 W max input power.
- Do not exceed Input Power Versus Time Limits of Table 1-1(SECTION I).



## LIST OF EFFECTIVE PAGES

The manual pages listed below which are affected by a current change or revision, are so identified by a revision number and an asterisk.

Date of issue for original and changed pages are:

|          |       |   |       |                |
|----------|-------|---|-------|----------------|
| Revision | ..... | 1 | ..... | January 1980   |
| Revision | ..... | 2 | ..... | January 1981   |
| Revision | ..... | 3 | ..... | May 1982       |
| Revision | ..... | 4 | ..... | September 1983 |
| Revision | ..... | 5 | ..... | August 1985    |
| Revision | ..... | 6 | ..... | November 1985  |
| Revision | ..... | 7 | ..... | April 1987     |
| Revision | ..... | 8 | ..... | February 1988  |
| Revision | ..... | 9 | ..... | January 1989   |

TOTAL NUMBER OF PAGES IN THIS MANUAL IS 296 CONSISTING OF FOLLOWING:

|                 |       |   |                |       |   |
|-----------------|-------|---|----------------|-------|---|
| Title Page      | ..... | 7 | m-i thru m-iii | ..... | 1 |
| *Copyright Page | ..... | 9 | m-iv Blank     | ..... | 1 |
| Caution Page    | ..... | 7 | 5-1 thru 5-13  | ..... | 1 |
| *A thru B       | ..... | 9 | 5-14 Blank     | ..... | 1 |
| i               | ..... | 2 | 5-15 thru 5-17 | ..... | 1 |
| ii              | ..... | 2 | 5-18 Blank     | ..... | 1 |
| o-i thru o-iii  | ..... | 1 | 6-1 thru 6-36  | ..... | 1 |
| o-iv Blank      | ..... | 1 | 7-1 thru 7-3   | ..... | 1 |
| 1-1             | ..... | 1 | 7-4 Blank      | ..... | 1 |
| 1-2 Blank       | ..... | 1 | 7-5 thru 7-7   | ..... | 1 |
| 1-3 thru 1-8    | ..... | 1 | 7-8 Blank      | ..... | 1 |
| 1-9             | ..... | 5 | s-i thru s-ii  | ..... | 1 |
| 1-10            | ..... | 1 | s-iv Blank     | ..... | 1 |
| 2-1 thru 2-3    | ..... | 1 | 8-1            | ..... | 5 |
| 2-4 Blank       | ..... | 1 | 8-2 thru 8-3   | ..... | 8 |
| 3-1 thru 3-3    | ..... | 1 | 8-4 Blank      | ..... | 8 |
| 3-4 Blank       | ..... | 1 | 8-5            | ..... | 8 |
| 3-5 thru 3-13   | ..... | 1 | 8-6 Blank      | ..... | 8 |
| 3-14 thru 3-16  | ..... | 8 | *8-7           | ..... | 9 |
| 3-17 thru 3-25  | ..... | 1 | *8-8 Blank     | ..... | 9 |
| 3-26            | ..... | 8 | *8-9           | ..... | 9 |
| 3-27 thru 3-32  | ..... | 1 | *8-10 Blank    | ..... | 9 |
| 4-1 thru 4-3    | ..... | 1 | *8-11          | ..... | 9 |
| *4-4            | ..... | 9 | *8-12 Blank    | ..... | 9 |
| 4-5 thru 4-8    | ..... | 1 | *8-13          | ..... | 9 |
| *4-9            | ..... | 9 | *8-14 Blank    | ..... | 9 |
| *4-10 Blank     | ..... | 9 | *8-15          | ..... | 9 |
| 4-11 thru 4-12  | ..... | 1 | *8-16 Blank    | ..... | 9 |
| *4-13           | ..... | 9 | *8-17          | ..... | 9 |
| 4-14 thru 4-16  | ..... | 1 | 8-18 Blank     | ..... | 5 |

# LIST OF EFFECTIVE PAGES

|       |             |   |
|-------|-------------|---|
| *8-19 | .....       | 9 |
| *8-20 | Blank ..... | 9 |
| 8-21  | .....       | 5 |
| 8-22  | Blank ..... | 5 |
| *8-23 | .....       | 9 |
| *8-24 | Blank ..... | 9 |
| 8-25  | .....       | 3 |
| 8-26  | Blank ..... | 3 |
| *8-27 | .....       | 9 |
| *8-28 | Blank ..... | 9 |
| 8-29  | .....       | 3 |
| 8-30  | Blank ..... | 3 |
| 8-31  | .....       | 1 |
| 8-32  | Blank ..... | 1 |
| 8-33  | .....       | 1 |
| 8-34  | Blank ..... | 1 |
| 8-35  | .....       | 8 |
| 8-36  | Blank ..... | 8 |
| *8-37 | .....       | 9 |
| *8-38 | Blank ..... | 9 |
| *8-39 | .....       | 9 |
| *8-40 | Blank ..... | 9 |
| 8-41  | .....       | 8 |
| 8-42  | Blank ..... | 8 |
| 8-43  | .....       | 8 |
| 8-44  | Blank ..... | 8 |
| *8-45 | .....       | 9 |
| *8-46 | Blank ..... | 9 |
| 8-47  | .....       | 8 |
| 8-48  | .....       | 1 |
| *8-49 | .....       | 9 |
| *8-50 | Blank ..... | 9 |
| 8-51  | .....       | 8 |
| 8-52  | Blank ..... | 8 |
| 8-53  | .....       | 8 |
| 8-54  | Blank ..... | 8 |
| *8-55 | .....       | 9 |
| *8-56 | Blank ..... | 9 |
| *8-57 | .....       | 9 |
| *8-58 | Blank ..... | 9 |
| 8-59  | .....       | 1 |
| 8-60  | Blank ..... | 1 |
| 8-61  | .....       | 1 |
| 8-62  | Blank ..... | 1 |
| 8-63  | .....       | 1 |
| 8-64  | Blank ..... | 1 |
| 8-65  | .....       | 8 |
| 8-66  | Blank ..... | 8 |
| 9-1   | .....       | 1 |

|       |                 |   |
|-------|-----------------|---|
| 9-2   | Blank .....     | 1 |
| *9-3  | thru 9-5 .....  | 9 |
| *9-6  | Blank .....     | 9 |
| 9-7   | .....           | 1 |
| 9-8   | Blank .....     | 1 |
| 9-9   | .....           | 1 |
| 9-10  | Blank .....     | 1 |
| 9-11  | .....           | 1 |
| 9-12  | Blank .....     | 1 |
| 9-13  | .....           | 1 |
| 9-14  | Blank .....     | 1 |
| 9-15  | .....           | 1 |
| 9-16  | Blank .....     | 1 |
| 9-17  | thru 9-20.....  | 1 |
| *9-21 | .....           | 9 |
| *9-22 | Blank .....     | 9 |
| 9-23  | .....           | 1 |
| 9-24  | .....           | 1 |
| *9-25 | .....           | 9 |
| *9-26 | Blank .....     | 9 |
| *9-27 | .....           | 9 |
| *9-28 | Blank .....     | 9 |
| 9-29  | thru 9-31 ..... | 1 |
| 9-32  | Blank .....     | 1 |
| *9-33 | thru 9-34 ..... | 9 |
| 9-35  | .....           | 1 |
| 9-36  | Blank .....     | 1 |
| 9-37  | .....           | 1 |
| 9-38  | Blank .....     | 1 |
| 9-39  | .....           | 1 |
| 9-40  | Blank .....     | 1 |
| 9-41  | thru 9-43 ..... | 1 |
| 9-44  | Blank .....     | 1 |
| 9-45  | .....           | 1 |
| 9-46  | Blank .....     | 1 |
| 9-47  | .....           | 1 |
| 9-48  | Blank .....     | 1 |
| 9-49  | .....           | 1 |
| 9-50  | Blank .....     | 1 |
| 9-51  | .....           | 1 |
| 9-52  | Blank .....     | 1 |
| 9-53  | .....           | 1 |
| 9-54  | Blank .....     | 1 |
| 10-1  | .....           | 1 |
| 10-2  | Blank .....     | 1 |
| 10-3  | .....           | 1 |
| 10-4  | Blank .....     | 1 |
| 10-5  | thru 10-6 ..... | 1 |

TABLE OF CONTENTS  
NAV-401L

GENERAL

|                                                  | <u>Page</u> |
|--------------------------------------------------|-------------|
| Title Page                                       |             |
| Table of Contents - General                      | i           |
| OPERATION                                        |             |
| Table of Contents - Operation                    | o-i         |
| List of Figures and Tables - Operation           | o-iii       |
| SECTION 1 General Description and Specifications | 1-1         |
| SECTION 2 Inspection and Installation            | 2-1         |
| SECTION 3 Operation                              | 3-1         |
| SECTION 4 Theory of Operation                    | 4-1         |
| MAINTENANCE                                      |             |
| Table of Contents - Maintenance                  | m-i         |
| List of Figures and Tables - Maintenance         | m-iii       |
| SECTION 5 Performance Tests                      | 5-1         |
| SECTION 6 Calibration Procedures                 | 6-1         |
| SECTION 7 I.C. Guide                             | 7-1         |
| SCHEMATICS                                       |             |
| Table of Contents - Section 8                    | s-i         |
| Table of Contents - Section 9                    | s-ii        |
| Table of Contents - Section 10                   | s-iii       |
| SECTION 8 Schematics                             | 8-1         |
| SECTION 9 Parts List                             | 9-1         |
| SECTION 10 Mechanical                            | 10-1        |







TABLE OF CONTENTS  
NAV-401L

OPERATION

|                                                          | <u>Page</u> |
|----------------------------------------------------------|-------------|
| <u>SECTION 1</u> General Description and Specifications. |             |
| 1    Description. . . . .                                | 1-1         |
| 2    Specifications . . . . .                            | 1-3         |
| 2-1    RF Output . . . . .                               | 1-3         |
| 2-2    MKR Signal. . . . .                               | 1-3         |
| 2-3    VOR Signal. . . . .                               | 1-4         |
| 2-4    LOC Signal. . . . .                               | 1-4         |
| 2-5    G/S Signal. . . . .                               | 1-5         |
| 2-6    COMM Signal . . . . .                             | 1-5         |
| 2-7    External Modulation . . . . .                     | 1-6         |
| 2-8    Distortion. . . . .                               | 1-6         |
| 2-9    Counter Characteristics . . . . .                 | 1-7         |
| 2-10    Monitor Meter Characteristics . . . . .          | 1-8         |
| 2-11    Bearing Monitor Circuit . . . . .                | 1-8         |
| 2-12    Spectral Purity . . . . .                        | 1-9         |
| 2-13    Power . . . . .                                  | 1-9         |
| 2-14    Physical Characteristics. . . . .                | 1-9         |
| <br><u>SECTION 2</u> Inspection and Installation.        |             |
| 1    Introduction . . . . .                              | 2-1         |
| 2    Grounding Requirements . . . . .                    | 2-1         |
| 3    Installation . . . . .                              | 2-1         |
| 4    Initial Inspection . . . . .                        | 2-1         |
| 5    Cleaning . . . . .                                  | 2-2         |
| 6    Inspection Procedures. . . . .                      | 2-2         |
| 7    Repacking for Shipping . . . . .                    | 2-3         |
| <br><u>SECTION 3</u> Operation.                          |             |
| 1    Introduction . . . . .                              | 3-1         |
| 2    Signals Simulated. . . . .                          | 3-1         |
| 3    General Usage of NAV-401L. . . . .                  | 3-1         |
| 4    Ramp Operation . . . . .                            | 3-2         |
| 5    Bench Operation. . . . .                            | 3-2         |
| 6    General Purpose Counter Operation. . . . .          | 3-2         |
| 7    Portable Operation . . . . .                        | 3-3         |

SECTION 4 Theory of Operation.

|    |                                                      |     |
|----|------------------------------------------------------|-----|
| 1  | Introduction . . . . .                               | 4-1 |
| 2  | Marker Signal Generation . . . . .                   | 4-1 |
| 3  | COMM Signal Generation . . . . .                     | 4-1 |
| 4  | VOR Signal Generation. . . . .                       | 4-2 |
| 5  | Localizer and Glide Slope Signal Generation. . . . . | 4-2 |
| 6  | Bearing Generator. . . . .                           | 4-3 |
| 7  | RF Section . . . . .                                 | 4-4 |
| 8  | Counter Section. . . . .                             | 4-6 |
| 9  | Monitoring Section . . . . .                         | 4-7 |
| 10 | Power Section. . . . .                               | 4-7 |

LIST OF FIGURES AND TABLES  
NAV-401L

OPERATION

Page

SECTION 1 General Description and Specifications.

|           |                                          |      |
|-----------|------------------------------------------|------|
| Fig. 1-1  | Low Pass Filter. . . . .                 | 1-6  |
| Table 1-1 | Input Power Versus Time Limits . . . . . | 1-8  |
| Table 1-2 | Tone Modulation Levels . . . . .         | 1-10 |

SECTION 3 Operation.

|           |                                                                                |      |
|-----------|--------------------------------------------------------------------------------|------|
| Table 3-1 | Correspondence Chart for Decibels, Volts and Watts (50 $\Omega$ load). . . . . | 3-5  |
| Table 3-2 | Correspondence Charts for 90 Hz and 150 Hz Tones. . . . .                      | 3-9  |
| Table 3-3 | 150 Hz and 90 Hz Tones Variable Phase Relationships. . . . .                   | 3-10 |
| Fig. 3-1  | NAV-401L Front and Rear Views. . . . .                                         | 3-11 |
| Table 3-4 | Controls, Indicators and Connectors. . . . .                                   | 3-12 |
| Fig. 3-2  | Front Panel Controls, Indicators and Connectors 1-5 . . . . .                  | 3-12 |
| Fig. 3-3  | Front Panel Controls, Indicators and Connectors 5-9 . . . . .                  | 3-14 |
| Fig. 3-4  | Front Panel Controls, Indicators and Connectors 10-13 . . . . .                | 3-16 |
| Fig. 3-5  | Front Panel Controls, Indicators and Connectors 13-19 . . . . .                | 3-18 |
| Fig. 3-6  | Front Panel Controls, Indicators and Connectors 20-26 . . . . .                | 3-20 |
| Fig. 3-7  | Front Panel Controls, Indicators and Connectors 27-31 . . . . .                | 3-22 |
| Fig. 3-8  | Rear Panel Controls, Indicators and Connectors . . . . .                       | 3-24 |
| Fig. 3-9  | Front Panel Controls, Indicators and Connectors (all) . . . . .                | 3-26 |
| Table 3-5 | Typical Test Control Settings. . . . .                                         | 3-27 |

SECTION 4 Theory of Operation

|          |                                             |      |
|----------|---------------------------------------------|------|
| Fig. 4-1 | Simplified Overall Block Diagram            | 4-9  |
| Fig. 4-2 | Simplified Tone Generator Block Diagram     | 4-11 |
| Fig. 4-3 | Simplified Bearing Generator Block Diagram  | 4-12 |
| Fig. 4-4 | Simplified RF Generator Block Diagram       | 4-13 |
| Fig. 4-5 | Simplified Counter Block Diagram            | 4-14 |
| Fig. 4-6 | Simplified Monitoring Section Block Diagram | 4-15 |
| Fig. 4-7 | Simplified Power Section Block Diagram      | 4-16 |



## GENERAL DESCRIPTION AND SPECIFICATIONS

### NAV-401L SECTION 1

#### 1 Description.

- 1-1 The NAV-401L is an FCC Type-Accepted bench and ramp test set designed to meet the electronic functional test requirements of Category I and Category II ILS Systems, Communication (COMM), Navigation (NAV), and Marker (MKR) Systems.
- 1-2 The NAV-401L is housed in a compact, portable case. It includes a signal generator with a variable attenuator which can be connected to the equipment under test by a radiated signal from a self-contained antenna or by a coax line. It can be operated under either crystal frequency control or in variable frequency mode in each band.
- 1-3 The NAV-401L generator can be modulated internally by a 1020Hz Indent tone, Marker, VHF Omnidirectional Range (VOR), Localizer (LOC) or Glide Slope (G/S) tones, or by an external signal.
- 1-4 The NAV-401L includes a six-digit counter which indicates the RF frequency of the signal generator on any band, the frequency of a COMM transmitter under test, any external signal input from 1 MHz to at least 300 MHz, or the VOR bearing selected by Bearing Select Switches.
- 1-5 An RF power meter is built-in to measure COMM transmitter power from 0-10W or 0-100W either peak or average power by selecting a switch position located on the Front Panel. A COMM transmitter demodulation output permits viewing or listening to COMM modulation.
- 1-6 A built-in Modulation Meter measures Signal Generator Percent of Modulation on any frequency band from 0-30% or 0-100%. Front Panel controls permit quick setting of modulation percentages.
- 1-7 A 90° bearing check monitor allows quick verification of basic VOR bearing from the VOR demod signal.
- 1-8 A nickel-cadmium battery and built-in charging system permit completely portable operation for up to 2 hours continuous duty with the counter off, one hour continuous duty with the counter on. Any time the set is plugged to an AC line, the battery is being charged. In battery operation, an automatic timer turns the set off after 6 to 10 minutes. The set can be recycled by pressing power switch to BAT position.



---

NAV-401L/402AP SPECIFICATIONS

---

NAV-401L (S/N 1500 and On)

NAV-402AP (S/N 101 and On)

2 Specifications.

2-1 RF OUTPUT

Power: Continuously variable from  
-7 dBm to -110 dBm (0.1 V to  
0.709  $\mu$ V)

Accuracy:  $\pm 2$  dB from -30 dBm to -110  
dBm (See enclosed -7 to  
-30 dBm Attenuator Correction  
Chart)

Frequency Range: MKR. . . 72 MHz to 78 MHz  
VOR/LOC. 107 MHz to 120 MHz  
COMM LO: 118 MHz to 136 MHz  
          HI: 134 MHz to 156 MHz  
G/S. . . 327 MHz to 337 MHz

Standard Crystal  
Frequencies: MKR XTL . . . 75.000 MHz  
VOR XTL . . . 108.000 MHz  
LOC XTL . . . 108.100 MHz  
G/S XTL . . . 334.700 MHz  
COMM XTL. . . 126.900 MHz

NOTE

Any channel frequency crystal  
may be custom installed in any  
of the bands.

RF Frequency Accuracy: Variable Frequency Mode with  
Digital Display indication:  
. . . . . 0.002%

Phase Lock Operation:  
25 kHz increments in MKR,  
LOC, VOR, and COMM bands:  
50 kHz increments in G/S  
band:  
. . . . . 0.002%

Crystal Control Mode: 0.005%

2-2 MKR SIGNAL

Tones: 1020 Hz ( $\pm 1\%$ ) Ident  
400 Hz ( $\pm 1\%$ )  
1300 Hz ( $\pm 1\%$ )  
3000 Hz ( $\pm 1\%$ )

---

NAV-401L/402AP SPECIFICATIONS

---

2-2 MKR SIGNAL (cont'd)

Modulation: Calibrated to 95%(±5%) for each tone. Variable from 3% to 96%.

2-3 VOR SIGNAL

Tones: 30 Hz (±0.02%) Reference  
30 Hz (±0.02%) Variable Phase  
9.96 kHz (±0.02%),  
480 (±25) Hz Deviation  
(S/N 1500 and above)  
1020 Hz (±1%) Ident

Modulation: Calibrated to 30(±2%) for each tone. Variable from 3% to 55%.

Bearing: 3599 digitally derived courses  
in 0.1 degree increments. Course  
Accuracy: ±0.1 degree

2-4 LOC SIGNAL

Tones: 90 Hz (±0.02%)  
150 Hz (±0.02%)  
1020 Hz (±1%) Ident

Modulation: 90 Hz and 150 Hz modulation levels  
calibrated to 20%(±2%). Variable  
from 3% to 35%.

Audio Tone modulation levels  
calibrated to 30%(±2%). Variable  
from 3% to 55%.

DDM: 0.093, 0.155 and 0.200 DDM, and  
Tone Delete. Accuracy: ±0.0013 DDM  
(1.3 µA). Variable Control: ±0.4 DDM.  
(See Table in SECTION 3)

---

NAV-401L/402AP SPECIFICATIONS

---

|                                                      |                                                                                                                                                                                                                 |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2-4 <u>LOC SIGNAL</u> (cont.)<br><u>Phase Shift:</u> | 90 Hz and 150 Hz phase locked to 5 times VOR BEARING SELECT SWITCH setting. 150 Hz selectable (Ref. to 90 Hz) in five degree increments. Accuracy: $\pm 1^\circ$ Typical. (See Table in SECTION 3)              |
| 2-5 <u>G/S SIGNAL</u><br><u>Tones:</u>               | 90 Hz ( $\pm 0.02\%$ )<br>150 Hz ( $\pm 0.02\%$ )                                                                                                                                                               |
| <u>Modulation:</u>                                   | Calibrated to 40% ( $\pm 2\%$ ) for each tone. Variable from 3% to 75%.                                                                                                                                         |
| <u>DDM:</u>                                          | 0.091, 0.175, and 0.40 DDM, and Tone Delete.<br>Accuracy: $\pm 0.0024$ DDM ( $\pm 2.0 \mu A$ )<br><br>Variable Control: $\pm 0.8$ DDM.<br>(See Table in SECTION 3)                                              |
| <u>Phase Shift:</u>                                  | 90 Hz and 150 Hz phase locked to 5 times VOR BEARING SELECT SWITCH setting. 150 Hz selectable (Ref. to 90 Hz) in five degree increments.<br>Accuracy: $\pm 1^\circ$ Typical. (See Table in SECTION 3)           |
| <u>Auxiliary Localizer Signal:</u>                   | Simultaneously selected and paired with G/S Crystal Signal. Output typically -18 dBm, independent of OUTPUT ATTENUATOR CONTROL setting.<br>Standard Frequency: 108.100 MHz<br>Frequency Accuracy: $\pm 0.005\%$ |
| 2-6 <u>COMM SIGNAL</u><br><u>Tones:</u>              | 1020 Hz ( $\pm 1\%$ ) Ident<br>400 Hz ( $\pm 1\%$ )<br>1300 Hz ( $\pm 1\%$ )<br>3000 Hz ( $\pm 1\%$ )                                                                                                           |

## 2-6 COMM SIGNAL (cont.)

### Modulation:

Calibrated to 30%(±2%) for each tone. Variable from 3% to 55%.

## 2-7 EXTERNAL MODULATION:

A 10 Hz to 20 kHz, 5 Volts peak to peak signal will typically produce 30% modulation for VOR, LOC, and COMM Signals, and 95% modulation for MKR Signals. G/S Signals cannot be externally modulated.

External modulation of VOR, LOC, COMM, and MKR Signals can be varied over the same ranges as the internal modulations discussed above.

## 2-8 DISTORTION

At Back Panel Demodulated Outputs with Filter (Figure 1-1):

|                   |           |
|-------------------|-----------|
| 1020 Hz . . . . . | 1.00% Max |
| 400 Hz . . . . .  | 1.00% Max |
| 1300 Hz . . . . . | 1.00% Max |
| 3000 Hz . . . . . | 1.00% Max |
| 30 Hz . . . . .   | 0.65% Max |
| 90 Hz . . . . .   | 0.65% Max |
| 150 Hz . . . . .  | 0.65% Max |

At Back Panel Demodulated Outputs without Filter:

|                   |           |
|-------------------|-----------|
| 1020 Hz . . . . . | 2.50% Max |
| 400 Hz . . . . .  | 2.50% Max |
| 1300 Hz . . . . . | 2.50% Max |
| 3000 Hz . . . . . | 2.50% Max |
| 30 Hz . . . . .   | 2.00% Max |
| 90 Hz . . . . .   | 2.00% Max |
| 150 Hz . . . . .  | 2.00% Max |

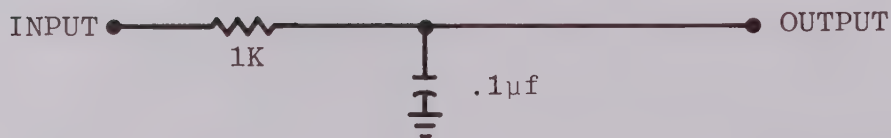


Figure 1-1 Low Pass Filter

2-9 COUNTER CHARACTERISTICS

|                                             |                                                                                                                                                                                                                                     |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Functions:</u>                           | Measures internal signal generator frequencies.<br>Measures frequency of external COMM transmitter.<br><br>Measures frequency of external signal at Counter Input.<br><br>Displays internal VOR Bearing as selected on Front Panel. |
| <u>Clock Oscillator Frequency:</u>          | 10 MHz                                                                                                                                                                                                                              |
| <u>Clock Oscillator Frequency Accuracy:</u> | Accurate within $\pm 0.002\%$<br>(Typically $\pm 0.0005\%$ over normal temperature and period of use).                                                                                                                              |
| <u>Counter Resolution:</u>                  | Hz . . . . . 1 Hz<br>kHz . . . . . 10 Hz<br>kHz . . . . . 100 Hz<br>MHz . . . . . 1 kHz                                                                                                                                             |
| <u>External Input Range:</u>                | Hz, kHz: 1 MHz to 10 MHz<br>kHz, MHz: 10 MHz to 300 MHz                                                                                                                                                                             |
| <u>Impedance:</u>                           | 50 $\Omega$ a.c. terminated.                                                                                                                                                                                                        |
| <u>Sensitivity:</u>                         | 0.08 V rms (-9 dBm) @ 10 MHz<br>0.15 V rms (-3 dBm) @ 200 MHz<br>0.23 V rms ( 0 dBm) @ 300 MHz                                                                                                                                      |
| <u>Maximum Counter Input Power:</u>         | 250 mW RF, or +24 dBm.                                                                                                                                                                                                              |

CAUTION

DO NOT EXCEED MAXIMUM INPUT POWER LEVEL (250 mW RF, or +24 dBm) TO COUNTER OR DAMAGE TO UNIT MAY RESULT.

2-10 MONITOR METER CHARACTERISTICS
Power Meter:
Function:

Measures COMM  
transmitter power  
from 0 to 100  
Watts.

Scales:

0 to 100 Watts  
0 to 10 Watts

Accuracy:
 $\pm 3\%$  of full scale,  
plus  $\pm 5\%$  of meter  
indication.

Maximum Input  
Power:

20 Watts CW  
Continuous Duty

TABLE 1-1

| INPUT POWER VERSUS TIME LIMITS |                            |                       |
|--------------------------------|----------------------------|-----------------------|
| Input Power<br>(Watts)         | ON Time Limit<br>(Minutes) | Maximum<br>Duty Cycle |
| 20 to 40                       | 5.0                        | 50%                   |
| 40 to 80                       | 1.0                        | 20%                   |
| 80 to 100                      | 0.5                        | 10%                   |

RF Level Monitor:

Center of scale indicates  
proper transmitter RF  
level

Battery Level:
Scale:

0 to 30 Volts

Accuracy:
 $\pm 5\%$  of reading

2-11 Bearing Monitor Circuit:
Range:
 $\pm 0.5$  degrees  
(0 degrees at meter  
center)

---

NAV-401L/402AP SPECIFICATIONS

---

2-12 SPECTRAL PURITY
Harmonics:

At least 15 dB below carrier level at -30 dBm output level, over entire frequency range.

Broadband Noise:

At least 70 dB below carrier level at -30 dBm output at  $\pm 50$  kHz.

Spectrum Analyzer Set-up:  
10 kHz Frequency Span,  
300 Hz Bandwidth,  
10 Hz Video Filter.

2-13 POWER
Battery:

An internal NICAD battery system permits a continuous duty cycle for 1.5 hours. The battery charger continuously charges the battery whenever the test set is connected to AC power.

AC Line:

105 to 120 Vac or 220 to 250 Vac, 50 to 400 Hz, 25 Watts.

2-14 PHYSICAL CHARACTERISTICS
Weight:

17 lbs. (7.7 kg.) complete

Width:

11.375 in (28.9 cm)

Height:

5.125 in (13.0 cm)

Depth:

16.125 in (41.0 cm)

---

NAV-401L/402AP SPECIFICATIONS

---

Table 1-2 Tone Modulation Levels

| BAND                                                                                                                                                                                                                                                                                                                             | TONE |        |      |       |        |       |        |        |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------|------|-------|--------|-------|--------|--------|------|
|                                                                                                                                                                                                                                                                                                                                  | 30Hz | 9960Hz | 90Hz | 150Hz | 1020Hz | 400Hz | 1300Hz | 3000Hz | Ext* |
| MKR                                                                                                                                                                                                                                                                                                                              | XX   | XX     | XX   | XX    | 95%    | 95%   | 95%    | 95%    | 95%  |
| VOR                                                                                                                                                                                                                                                                                                                              | 30%  | 30%    | XX   | XX    | 30%    | 30%   | 30%    | 30%    | 30%  |
| LOC                                                                                                                                                                                                                                                                                                                              | XX   | XX     | 20%  | 20%   | 30%    | 30%   | 30%    | 30%    | 30%  |
| G/S                                                                                                                                                                                                                                                                                                                              | XX   | XX     | 40%  | 40%   | XX     | XX    | XX     | XX     | XX   |
| COMM                                                                                                                                                                                                                                                                                                                             | XX   | XX     | XX   | XX    | 30%    | 30%   | 30%    | 30%    | 30%  |
| NOTE: 95% Modulation accuracy $\pm 5\%$ except EXT<br>40% Modulation accuracy $\pm 2\%$ except EXT<br>30% Modulation accuracy $\pm 2\%$ except EXT<br>20% Modulation accuracy $\pm 2\%$ except EXT<br>XX - Tone not available<br>*External Input approximately 5Vp-p. Input impedance is 20K $\Omega$ in series with 33 $\mu$ f. |      |        |      |       |        |       |        |        |      |

INSPECTION AND INSTALLATION  
NAV-401L/402AP      SECTION 2

1      Introduction.

1-1 Each IFR Precision Simulator is carefully inspected for mechanical and electrical quality before shipment from the factory. On receipt, the instrument should be physically free of marks and scratches, and in perfect mechanical and electrical order.

2      Grounding Requirements.

2-1 To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. All IFR instruments are equipped with a three-conductor power cord which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cord three-prong connector is the ground pin.

2-2 To preserve this protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

3      Installation.

3-1 No special installation procedures are necessary for this equipment.

4      Initial Inspection.

4-1 The instrument should be inspected immediately for possible in-transit physical damage. A check for supplied accessories, and a test of the electrical performance of the instrument (as outlined in SECTION 5 of this manual) should also be made. Any damage or deficiency should be reported immediately to the carrier and a claim filed, if necessary. Refer to the LIMITED WARRANTY AND SERVICE INSTRUCTIONS of this manual for delineation of responsibilities and liabilities. Follow the directions in the LIMITED WARRANTY AND SERVICE INSTRUCTIONS when it becomes necessary to ship the instrument.

## 5 Cleaning.

5-1 It is wise to clean the dust, cobwebs, and other debris out of the test set prior to periodic inspection, repair or calibration. Some shops clean their test equipment on a regular basis such as biannual or annual proof-of-performance checks.

5-2 Internal chassis parts and frame should be wiped with a lint-free cloth moistened with rubbing alcohol. The Front Panel may also be cleaned with rubbing alcohol. Safety solvent should be used to remove tar and oil from the outside case.

5-3 Dust removal is best done with a hand controlled dry air jet of 25 to 50 psi ( $1.827 \text{ kg/cm}^2$  to  $3.653 \text{ kg/cm}^2$ ). The Rear Panel should be cleaned with a dry cloth only.

5-4 CARE MUST BE TAKEN TO AVOID BREAKING WIRES OR SHORTING COMPONENT LEADS TOGETHER DURING CLEANING.

## 6 Inspection Procedures.

6-1 General. Inspection is necessary to determine the general condition of the test set. It has been determined through hard experience that deliberate moving, however slight, of the discrete components on the various PC Boards and other assemblies often causes unnecessary circuit problems and can quickly change simple problems into complex ones. Therefore, IFR recommends ONLY A VISUAL INSPECTION without touching the components. Test set owners and operators should be aware that ANY opening of the instrument casing can result in calibration deviations. Complex modules, such as RF modules, should NOT be opened during Preliminary Inspection.

6-2 Chassis. Inspect the chassis for tightness of subassemblies, damaged chassis-mounted connectors, and corrosion or damage to the metal surface. Surface damage may indicate further damage to parts in the area.

6-3 Capacitors. Inspect all readily available capacitors for loose mounting, deformities or obvious physical damage, and leakage or corrosion around the leads.

6-4 Connectors. Examine all readily accessible coax connectors for loose or broken parts, cracked insulation, and bad contacts. DO NOT disassemble connectors within the test set.

6-5 Potentiometer Controls. Any Front Panel potentiometer control that feels rough when rotated should be checked with an ohmmeter for proper operation.

6-6 Printed Circuit (PC) Boards. (Readily accessible PC Boards only). Check the connectors and mating plugs for corrosion and damage. Inspect all mounted components, including crystals and IC's for damage. The PC Boards should be free of all foreign material.

6-7 Resistors. Inspect all readily available resistors for cracked, broken, charred, or blistered bodies and loose or corroded soldering connections.

6-8 Semiconductors. Inspect all readily available diodes, rectifiers, and transistors for cracked, broken, charred, or discolored bodies. Check the ends of the components to see that the seals around the leads are in place and in good condition.

6-9 Switches. Examine all readily available toggle switches for loose levers, terminals, and switch body connections to frame. The line switch contacts should not be bent or the switch action too loose.

6-10 Transformer. Inspect the transformer for signs of excessive heating, broken or charred insulation, and loose mounting hardware.

6-11 Wiring. Inspect all the wiring of the chassis for broken or loose ends and connections and for proper dress relative to other chassis parts. All the laced wiring should be tight with the ends securely tied.

## 7 Repacking for Shipping.

7-1 The LIMITED WARRANTY AND SERVICE INSTRUCTIONS contain detailed directions for repacking and shipping. Additional questions may be directed to the IFR Shipping Department.

7-2 Any instrument shipped to IFR for any reason MUST be tagged with: (1) its owner's identification, (2) the service or repair required, (3) its model number, and (4) its full serial number. Identify the instrument by prefix, model, and serial number in ALL correspondence.

7-3 IFR Precision Equipment should be shipped ONLY in their original containers. If the original container is not available, contact IFR for shipping instructions.

7-4 DO NOT return an instrument or its component parts to IFR without first receiving authorization from the IFR Customer Service Department. Refer to the LIMITED WARRANTY AND SERVICE INSTRUCTIONS for complete directions.



OPERATION  
NAV-401L SECTION 3

1 Introduction.

1-1 This section contains notes on general usage, tables used in operation of the NAV-401L; illustrations and descriptions of all controls, indicators and connectors; description of signals simulated, and operation procedures.

2 Signals Simulated.

2-1 The NAV-401L is a completely self-contained bench and ramp test instrument for: MARKER, VOR, ILS, and COMM equipment. The NAV-401L simulates MARKER signals with Inner (3000 Hz), Middle (1300 Hz) and Outer (400 Hz) tones. VOR Ground Station signals are simulated by an RF signal modulated by a 30 Hz reference signal, a variable 30 Hz signal, and a 9960 Hz signal. Localizer (LOC) signals are simulated by RF modulated by 90 and 150 Hz tones. Glide Slope (G/S) signals are simulated by modulating RF with 90 and 150 Hz tones. A second localizer frequency paired with G/S frequency is available as an option on the NAV-401L (standard on the NAV-402AP). COMM signals are simulated by RF modulated by the 400, 1300, or 3000 Hz MARKER tones or the 1020 Hz IDENT tone. IDENT may also be applied to MARKER, VOR, or Localizer signals.

3 General Usage of NAV-401L.

- 3-1 Connection to equipment under test, operation of NAV-401L controls and calibration of LOC and G/S course centering accuracy has been made as simple as possible. Bench and ramp operation of the NAV-401L are very similar. Differences in bench and ramp operation are given in the following two paragraphs.
- 3-2 The NAV-401L is an FCC Type accepted instrument and cannot be used in VAR (variable) frequency modes during ramp use. Any test signals radiated from the antenna must be crystal controlled. IFR does not authorize the NAV-401L to be externally modulated on any band during ramp use. This includes microphones, audio generators, etc.
- 3-3 During ramp testing, it is recommended to conserve battery power by operating the counter readout only when necessary. A push-button switch that controls power to the readout assembly is part of Counter Mode Switch.

#### 4 Ramp Operation.

- 4-1 With the possible exception of Marker Beacon, most NAV COMM systems of a typical avionics package may be checked while NAV-401L is placed in a vertical position in the cockpit. The antenna is extended from two to three feet vertically. With the antenna on the RF Output Jack (10), the VOR, LOC, and G/S modes of NAV COMM Receivers may be checked and indicators operated through their limits. The COMM Receiver may also be operated, if desired, modulating the NAV-401L with either the 400, 1300, or 3000 Hz tones or the 1020 Hz IDENT tone.
- 4-2 On some installations, the Marker Antenna is located far aft on the fuselage. When this situation occurs, and receiver sensitivity is low (-35 to -45 dBm); the NAV-401L situated in the cockpit does not radiate enough RF to operate the Receiver. Moving the NAV-401L outside the aircraft will normally give more than enough signal strength to completely check Marker audio and lights.
- 4-3 To check COMM transmitter frequencies from cockpit, connect COMM Transmitter Output to COMM Transmitter Input Connector (11) and select MHz on Counter Mode Switch (3). Test set will read out the COMM Transmitter frequency when Transmitter is keyed.

#### 5 Bench Operation.

- 5-1 Bench testing and alignment procedures usually dictate use of direct coax connections between the NAV-401L and equipment under test. NAV-401L Attenuator Dial readout is the RF level in dBm present at RF Output Connector (10) into 50 Ohms. To make accurate sensitivity measurements, the loss in dBm of the connecting coaxes must be known.

#### CAUTION

Most COMM Receiver Antenna Connectors are also used for the COMM Transmitter Connector. Precautions should be taken not to key the Transmitter with the COMM Antenna Connector connected to the NAV-401L RF Output Connector (10). Damage to the Attenuator and Signal Generator System may result.

#### 6 General Purpose Counter Operation.

- 6-1 With Tone Select Switch in the CTR IN position, NAV-401L Counter may be utilized as a general utility counter. Frequencies from 1 MHz to 300 MHz can be measured.

6-1 (Cont.) Counter Mode Switch (3) can be used in any of four time base positions; Hz, kHz, kHz, or MHz.

## 7 Portable Operation.

- 7-1 Built-in battery supply permits completely portable ramp operation for up to two hours with Counter Readout off and one hour with Counter Readout on. Timer allows ample time for most ramp equipment checks but protects against battery being drained by set.
- 7-2 Between periods of ramp use, battery should be charged to maintain long life. Charger operation is automatic and is on whenever NAV-401L is connected to a.c. power. The set does not have to be turned on. The charger automatically causes charging current to be proportional to battery charge condition. Overnight charging is recommended.

### NOTE

If the NAV-401L test set is used only for bench operation, the NICAD batteries can lose their storage ability. The test set should be periodically operated on battery power to allow the batteries to partially discharge.

- 7-3 Battery voltage is measured by placing the Monitor Meter Function Switch (30) in BAT position. The 0 to 30% scale shows battery voltage. Less than 12.5 V indicates a discharged battery. Portable operation should never be attempted at this voltage level. An automatic low voltage cutoff circuit will turn the NAV-401L off just below this level. Normal battery charged condition will be indicated as 15 V or greater.
- 7-4 To operate the LOC and G/S outputs simultaneously, first adjust all controls for normal G/S operation (G/S XTAL mode, only). The Output Attenuator varies the RF level of the G/S signal; and G/S DDM Controls vary the DDM of G/S signal. Next, select LOC with the AVG/PEAK LOC XMTR ON Switch (12). This activates a separate Localizer generator within the NAV-401L. This generator output is combined with the G/S output at the RF Output Connector (10) at the fixed level of -18 dBm (approx.). The Attenuator does not affect LOC output level in this mode. LOC DDM Controls vary the DDM of Localizer signal.



Table 3-1. Correspondence Chart for Decibels, Volts, and Watts  
(50Ω load)

| Decibels | Volts | Watts   |
|----------|-------|---------|
| +40dBw   | 709V  | 10,000W |
| +39dBw   | 633V  | 7,940W  |
| +38dBw   | 563V  | 6,320W  |
| +37dBw   | 501V  | 5,000W  |
| +36dBw   | 447V  | 3,980W  |
| +35dBw   | 399V  | 3,160W  |
|          |       |         |
| +34dBw   | 355V  | 2,510W  |
| +33dBw   | 317V  | 2,000W  |
| +32dBw   | 282V  | 1,590W  |
| +31dBw   | 252V  | 1,260W  |
| +30dBw   | 224V  | 1,000W  |
|          |       |         |
| +29dBw   | 200V  | 794W    |
| +28dBw   | 178V  | 632W    |
| +27dBw   | 159V  | 500W    |
| +26dBw   | 141V  | 398W    |
| +25dBw   | 126V  | 316W    |
|          |       |         |
| +24dBw   | 112V  | 251W    |
| +23dBw   | 100V  | 200W    |
| +22dBw   | 89.1V | 159W    |
| +21dBw   | 79.5V | 126W    |
| +20dBw   | 70.9V | 100W    |
|          |       |         |
| +19dBw   | 63.3V | 79.4W   |
| +18dBw   | 56.3V | 63.2W   |
| +17dBw   | 50.1V | 50.0W   |
| +16dBw   | 44.7V | 39.8W   |
| +15dBw   | 39.9V | 31.6W   |
|          |       |         |
| +14dBw   | 35.5V | 25.1W   |
| +13dBw   | 31.7V | 20.0W   |
| +12dBw   | 28.2V | 15.9W   |
| +11dBw   | 25.2V | 12.6W   |
| +10dBw   | 22.4V | 10.0W   |

| Decibels | Volts   | Watts   |
|----------|---------|---------|
| +9dBw    | 20.0V   | 7.94W   |
| +8dBw    | 17.8V   | 6.32W   |
| +7dBw    | 15.9V   | 5.00W   |
| +6dBw    | 14.1V   | 3.98W   |
| +5dBw    | 12.6V   | 3.16W   |
|          |         |         |
| +4dBw    | 11.2V   | 2.51W   |
| +3dBw    | 10.0V   | 2.00W   |
| +2dBw    | 8.91V   | 1.59W   |
| +1dBw    | 7.95V   | 1.26W   |
| 0dBw =   |         | 1.00W = |
| +30dBm   | 7.09V   | 1000mW  |
|          |         |         |
| +29dBm   | 6.33V   | 794mW   |
| +28dBm   | 5.63V   | 632mW   |
| +27dBm   | 5.01V   | 500mW   |
| +26dBm   | 4.47V   | 298mW   |
| +25dBm   | 3.99V   | 316mW   |
|          |         |         |
| +24dBm   | 3.55V   | 251mW   |
| +23dBm   | 3.17V   | 200mW   |
| +22dBm   | 2.82V   | 159mW   |
| +21dBm   | 2.52V   | 126mW   |
| +20dBm   | 2.24V   | 100mW   |
|          |         |         |
| +19dBm   | 2.00V   | 79.4mW  |
| +18dBm   | 1.78V   | 63.2mV  |
| +17dBm   | 1.59V   | 50.0mW  |
| +16dBm   | 1.41V   | 39.8mW  |
| +15dBm   | 1.26V   | 31.6mW  |
|          |         |         |
| +14dBm   | 1.12V   | 25.1mW  |
| +13dBm   | 1.00V = | 20.0mW  |
|          | 1000mV  |         |
| +12dBm   | 891mV   | 15.9mW  |
| +11dBm   | 795mV   | 12.6mW  |
| +10dBm   | 709mV   | 10.0mW  |

Table 3-1 (cont.)

| Decibels | Volts  | Watts              |
|----------|--------|--------------------|
| +9dBm    | 633mV  | 7.94mW             |
| +8dBm    | 563mV  | 6.32mW             |
| +7dBm    | 501mV  | 5.00mW             |
| +6dBm    | 447mV  | 3.98mW             |
| +5dBm    | 399mV  | 3.16mW             |
|          |        |                    |
| +4dBm    | 355mV  | 2.51mW             |
| +3dBm    | 317mV  | 2.00mW             |
| +2dBm    | 282mV  | 1.59mW             |
| +1dBm    | 252mV  | 1.26mW             |
| 0dBm     | 224mV  | 1.00mW =<br>1000uW |
|          |        |                    |
| -1dBm    | 200mV  | 794uW              |
| -2dBm    | 178mV  | 632uW              |
| -3dBm    | 159mV  | 500uW              |
| -4dBm    | 141mV  | 398uW              |
| -5dBm    | 126mV  | 316uW              |
|          |        |                    |
| -6dBm    | 122mV  | 251uW              |
| -7dBm    | 100mV  | 200uW              |
| -8dBm    | 89mV   | 159uW              |
| -9dBm    | 79mV   | 126uW              |
| -10dBm   | 70.9mV | 100uW              |
|          |        |                    |
| -11dBm   | 63.3mV | 79.4uW             |
| -12dBm   | 56.3mV | 63.2uW             |
| -13dBm   | 50.1mV | 50.0uW             |
| -14dBm   | 44.7mV | 39.8uW             |
| -15dBm   | 39.9mV | 31.6uW             |
|          |        |                    |
| -16dBm   | 35.5mV | 25.1uW             |
| -17dBm   | 31.7mV | 20.0uW             |
| -18dBm   | 28.2mV | 15.9uW             |
| -19dBm   | 25.2mV | 12.6uW             |
| -20dBm   | 22.4mV | 10.0uW             |
|          |        |                    |
| -21dBm   | 20.0mV | 7.94uW             |
| -22dBm   | 17.8mV | 6.32uW             |
| -23dBm   | 15.9mV | 5.00uW             |
| -24dBm   | 14.1mV | 3.98uW             |
| -25dBm   | 12.6mV | 3.16uW             |

| Decibels | Volts               | Watts              |
|----------|---------------------|--------------------|
| -26dBm   | 11.2mV              | 2.51uW             |
| -27dBm   | 10.0mV              | 2.00uW             |
| -28dBm   | 8.9mV               | 1.59uW             |
| -29dBm   | 7.95mV              | 1.26uW             |
| -30dBm   | 7.09mV              | 1.00uW =<br>1000nW |
|          |                     |                    |
| -31dBm   | 6.33mV              | 794nW              |
| -32dBm   | 5.63mV              | 632nW              |
| -33dBm   | 5.01mV              | 500nW              |
| -34dBm   | 4.47mV              | 398nW              |
| -35dBm   | 3.99mV              | 316nW              |
|          |                     |                    |
| -36dBm   | 3.55mV              | 251nW              |
| -37dBm   | 3.17mV              | 200nW              |
| -38dBm   | 2.82mV              | 159nW              |
| -39dBm   | 2.52mV              | 126nW              |
| -40dBm   | 2.24mV              | 100nW              |
|          |                     |                    |
|          |                     | 79.4nW             |
| -41dBm   | 2.00mV              | 63.2nW             |
| -42dBm   | 1.78mV              | 50.0nW             |
| -43dBm   | 1.59mV              | 39.8nW             |
| -44dBm   | 1.41mV              | 31.6nW             |
| -45dBm   | 1.26mV              |                    |
|          |                     |                    |
| -46dBm   | 1.12mV              | 25.1nW             |
| -47dBm   | 1.00mV =<br>1,000uV | 20.0nW             |
| -48dBm   | 891uV               | 15.9nW             |
| -49dBm   | 795uV               | 12.6nW             |
| -50dBm   | 709uV               | 10.0nW             |
|          |                     |                    |
| -51dBm   | 633uV               | 7.94nW             |
| -52dBm   | 563uV               | 6.32nW             |
| -53dBm   | 501uV               | 5.00nW             |
| -54dBm   | 447uV               | 3.98nW             |
| -55dBm   | 399uV               | 3.16nW             |
|          |                     |                    |
| -56dBm   | 355uV               | 2.51nW             |
| -57dBm   | 317uV               | 2.00nW             |
| -58dBm   | 282uV               | 1.59nW             |
| -59dBm   | 252uV               | 1.26nW             |
| -60dBm   | 224uV               | 1.00nW =<br>100pW  |

Table 3-1 (cont.)

| Decibels | Volts  | Watts              |
|----------|--------|--------------------|
| -61dBm   | 200uV  | 794pW              |
| -62dBm   | 178uV  | 632pW              |
| -63dBm   | 159uV  | 500pW              |
| -64dBm   | 141uV  | 398pW              |
| -65dBm   | 126uV  | 316pW              |
| -66dBm   | 112uV  | 251pW              |
| -67dBm   | 100uV  | 200pW              |
| -68dBm   | 89.1uV | 159pW              |
| -69dBm   | 79.5uV | 126pW              |
| -70dBm   | 70.9uV | 100pW              |
| -71dBm   | 63.3uV | 79.4pW             |
| -72dBm   | 56.3uV | 63.2pW             |
| -73dBm   | 50.1uV | 50.0pW             |
| -74dBm   | 44.7uV | 39.8pW             |
| -75dBm   | 39.9uV | 31.6pW             |
| -76dBm   | 35.5uV | 25.1pW             |
| -77dBm   | 31.7uV | 20.0pW             |
| -78dBm   | 28.2uV | 15.9pW             |
| -79dBm   | 25.2uV | 12.6pW             |
| -80dBm   | 22.4uV | 10.0pW             |
| -81dBm   | 20.0uV | 7.94pW             |
| -82dBm   | 17.8uV | 6.32pW             |
| -83dBm   | 15.9uV | 5.00pW             |
| -84dBm   | 14.1uV | 3.98pW             |
| -85dBm   | 12.6uV | 3.16pW             |
| -86dBm   | 11.2uV | 2.51pW             |
| -87dBm   | 10.0uV | 2.00pW             |
| -88dBm   | 89.1uV | 1.59pW             |
| -89dBm   | 7.95uV | 1.26pW             |
| -90dBm   | 7.09uV | 1.00pW =<br>1000fW |
| -91dBm   | 6.33uV | 794fW              |
| -92dBm   | 5.63uV | 632fW              |
| -93dBm   | 5.01uV | 500fW              |
| -94dBm   | 4.47uV | 398fW              |
| -95dBm   | 3.99uV | 316fW              |

| Decibels | Volts               | Watts              |
|----------|---------------------|--------------------|
| -96dBm   | 3.55uV              | 251fW              |
| -97dBm   | 3.17uV              | 200fW              |
| -98dBm   | 2.82uV              | 159fW              |
| -99dBm   | 2.52uV              | 126fW              |
| -100dBm  | 2.24uV              | 100fW              |
| -101dBm  | 2.00uV              | 79.4fW             |
| -102dBm  | 1.78uV              | 63.2fW             |
| -103dBm  | 1.59uV              | 50.0fW             |
| -104dBm  | 1.41uV              | 39.8fW             |
| -105dBm  | 1.26uV              | 31.6fW             |
| -106dBm  | 1.12uV              | 25.1fW             |
| -107dBm  | 1.00uV =<br>1,000nV | 20.0fW             |
| -108dBm  | 891nV               | 15.9fW             |
| -109dBm  | 795nV               | 12.6fW             |
| -110dBm  | 709nV               | 10fW               |
| -111dBm  | 633nV               | 7.94fW             |
| -112dBm  | 563nV               | 6.32fW             |
| -113dBm  | 501nV               | 5.00fW             |
| -114dBm  | 447nV               | 3.98fW             |
| -115dBm  | 399nV               | 3.16fW             |
| -116dBm  | 355nV               | 2.51fW             |
| -117dBm  | 317nV               | 2.00fW             |
| -118dBm  | 282nV               | 1.59fW             |
| -119dBm  | 252nV               | 1.26fW             |
| -120dBm  | 224nV               | 1.00fW =<br>1000aW |
| -121dBm  | 200nV               | 794aW              |
| -122dBm  | 178nV               | 632aW              |
| -123dBm  | 159nV               | 500aW              |
| -124dBm  | 141nV               | 398aW              |
| -125dBm  | 126nV               | 316aW              |
| -126dBm  | 112nV               | 251aW              |
| -127dBm  | 100nV               | 200aW              |
| -128dBm  | 89.1nV              | 150aW              |
| -129dBm  | 79.5nV              | 126aW              |
| -130dBm  | 70.9nV              | 100aW              |

Table 3-1 (cont.)

| Decibels | Volts  | Watts  |
|----------|--------|--------|
| -131dBm  | 63.3nV | 79.4aW |
| -132dBm  | 56.3nV | 63.2aW |
| -133dBm  | 50.1nV | 50.0aW |
| -134dBm  | 44.7nV | 39.8aW |
| -135dBm  | 39.9nV | 31.6aW |

| Decibels | Volts  | Watts  |
|----------|--------|--------|
| -136dBm  | 35.5nV | 25.1aW |
| -137dBm  | 31.7nV | 20.0aW |
| -138dBm  | 28.2nV | 15.9aW |
| -139dBm  | 25.2nV | 12.6aW |
| -140dBm  | 22.4nV | 10.0aW |

dBw - decibels referenced to one watt

dBm - decibels referenced to one milliwatt

V - volts

mV - millivolts (volts x  $10^{-3}$ )

uV - microvolts (volts x  $10^{-6}$ )

nV - nanovolts (volts x  $10^{-9}$ )

W - watts

mW - milliwatts (watts x  $10^{-3}$ )

uW - microwatts (watts x  $10^{-6}$ )

nW - nanowatts (watts x  $10^{-9}$ )

pW - picowatts (watts x  $10^{-12}$ )

fW - femtowatts (watts x  $10^{-15}$ )

aW - attowatts (watts x  $10^{-18}$ )

Table 3-2. Correspondence Charts for 90Hz and 150Hz Tones

## LOCALIZER

| Tone Difference Values                                                                                                                                                    |      |          | Course Deviation Indicator    |           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------|-------------------------------|-----------|
| 90Hz and 150Hz<br>% Modulation                                                                                                                                            | DDM  | Decibels | Deflection                    | Microamps |
| 20.00, 20.00                                                                                                                                                              | 0    | 0        | Centered                      | 0         |
| 15.35, 24.65                                                                                                                                                              | .093 | 4.114    | Standard                      | 90        |
| 12.25, 27.75                                                                                                                                                              | .155 | 7.102    | Full Scale                    | 150       |
| 10.00, 30.00                                                                                                                                                              | .200 | 9.542    | More than full<br>scale       | 194       |
| 0.00, 40.00                                                                                                                                                               | .4   | Infinity | Full one tone<br>delete other | 387       |
| NOTE: •Standard ODI deflection = 30% of full scale (linear movement).<br>•Deflections in microamps apply to indicators with full scale deflection current of 150 $\mu$ A. |      |          |                               |           |

## GLIDE SLOPE

| Tone Difference Values                                                                                                                                                              |      |          | G/S Deviation Indicator       |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------|-------------------------------|-----------|
| 90Hz and 150Hz<br>% Modulation                                                                                                                                                      | DDM  | Decibels | Deflection                    | Microamps |
| 40.00, 40.00                                                                                                                                                                        | 0    | 0        | Centered                      | 0         |
| 35.45, 44.55                                                                                                                                                                        | .091 | 1.988    | Standard                      | 78        |
| 31.25, 48.75                                                                                                                                                                        | .175 | 3.622    | Full Scale                    | 150       |
| 20.00, 60.00                                                                                                                                                                        | .400 | 9.542    | More than full<br>scale       | 343       |
| 0.00, 80.00                                                                                                                                                                         | .8   | Infinity | Full one tone<br>delete other | 686       |
| NOTE: •Standard G/S indicator deflection = 53% of full scale (linear movement).<br>•Deflections in microamps apply to indicators with full scale deflection current of 150 $\mu$ A. |      |          |                               |           |

Table 3-3. 150Hz and 90Hz Tones Variable Phase Relationships

| VOR BRG<br>Switch<br>Position | 150Hz Phase<br>Relative<br>to 90Hz |
|-------------------------------|------------------------------------|
| 000.0                         | 0°                                 |
| 001.0                         | +5°                                |
| 002.0                         | +10°                               |
| 003.0                         | +15°                               |
| 004.0                         | +20°                               |
| 005.0                         | +25°                               |
| 006.0                         | +30°                               |
| 007.0                         | +35°                               |
| 008.0                         | +40°                               |
| 009.0                         | +45°                               |
| 010.0                         | +50°                               |
| 011.0                         | +55°                               |
| 012.0                         | +60°                               |
| 013.0                         | +65°                               |
| 014.0                         | +70°                               |
| 015.0                         | +75°                               |
| 016.0                         | +80°                               |
| 017.0                         | +85°                               |
| 018.0                         | +90°                               |
| 019.0                         | +95°                               |
| 020.0                         | +100°                              |
| 021.0                         | +105°                              |
| 022.0                         | +110°                              |
| 023.0                         | +115°                              |
| 024.0                         | +120° or 0° *                      |

\* +120° will have the same phase relationship as 0°; therefore, only 1° through 12° BRG switch positions need be used.

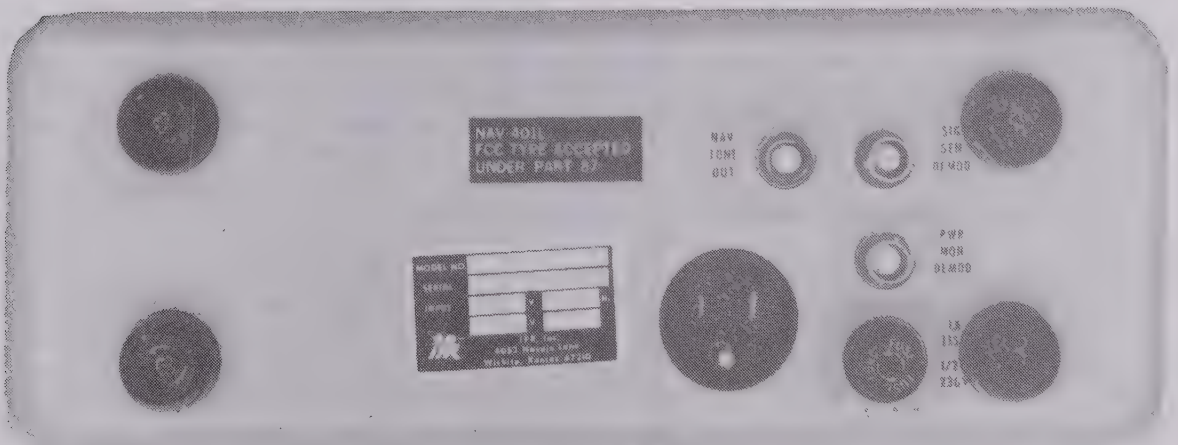
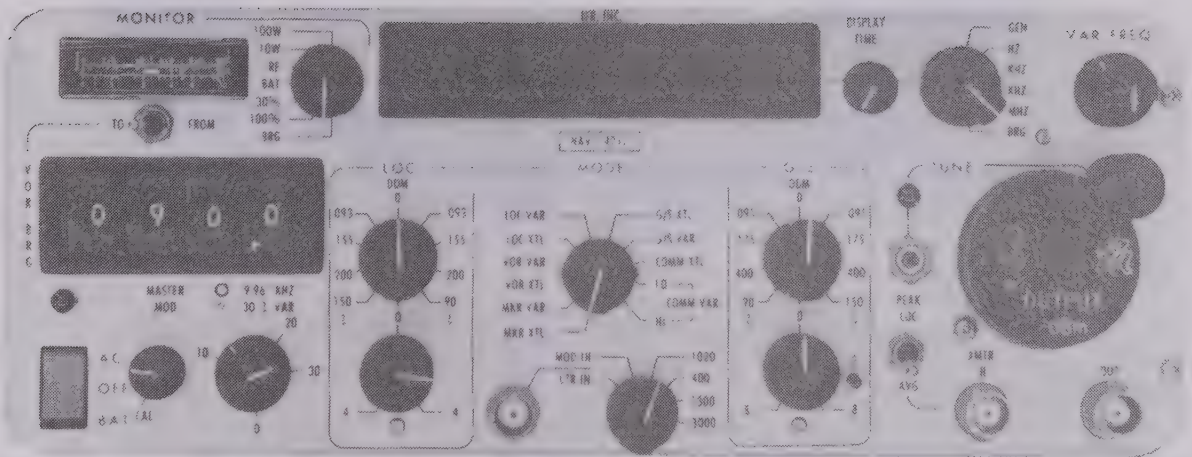


Fig. 3-1 NAV-401L Front and Rear Views

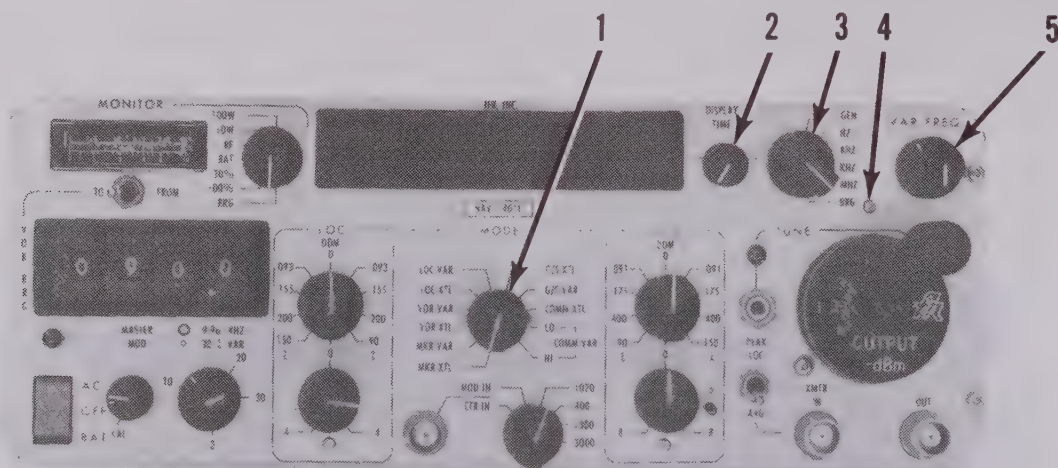


Fig. 3-2

| CONTROL/INDICATOR/CONNECTOR | FUNCTION                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Frequency Mode Switch    | Selects frequency band to be used: MARKER (MKR), VOR, Localizer (LOC), Glide Slope (G/S), or COMM. Each band except COMM is divided into two positions: a crystal controlled frequency position, and a variable frequency position, COMM band utilizes three switch positions: a crystal controlled position, and two variable frequency positions. |
| 2. Display Time Control     | Varies Counter update time. CCW rotation causes interval between updates to decrease. In full cw position, the count is held indefinitely.                                                                                                                                                                                                          |
| 3. Counter Mode Switch      | Selects source of signal to be counted. In GEN position, displays frequency of internal signal generator. In Hz, kHz, kHz, or MHz positions, Counter measures frequency of a COMM Transmitter connected to XMTR IN Connector, or external signal source. External signal                                                                            |

| CONTROL/INDICATOR/CONNECTOR    | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. (Cont.) Counter Mode Switch | <p>must be applied to MOD IN/CTR IN Connector (18). In BRG (Bearing) position, the input to Counter is the output of digital bearing determining circuitry. Display should equal VOR BRG Switch (27) indication. This provides a check on bearing selection circuits. In BRG position, bearing monitor circuitry also checks VOR modulation for proper operation at 90°.</p> <p>A pushbutton switch is incorporated into Counter Mode Switch which applies power to Counter Readout in either battery or a.c. operation. This switch is activated by depressing Counter Mode Switch Knob. It is highly recommended during portable operation to use Counter Readout only when necessary.</p> |
| 4. Meter Bearing Center Adjust | <p>Used to center Monitor Meter (29) to set a reference level in internal bearing check operation. Monitor Meter Function Switch (30) should be in the BRG position and Counter Mode Switch (3) should be in any position except BRG while the Meter is being centered.</p>                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5. Variable Frequency Controls | <p>Coarse and fine controls used to manually sweep the Internal Signal Generator frequency. CW rotation of these controls increases the frequency. Frequency Mode Switch (1) must be in a VAR position for manual sweeping. Coarse Control, larger knob, gives from 1 to 2 MHz deviation per turn. Fine Control, smaller knob, gives approximately 20 to 40 kHz deviation per turn.</p>                                                                                                                                                                                                                                                                                                      |

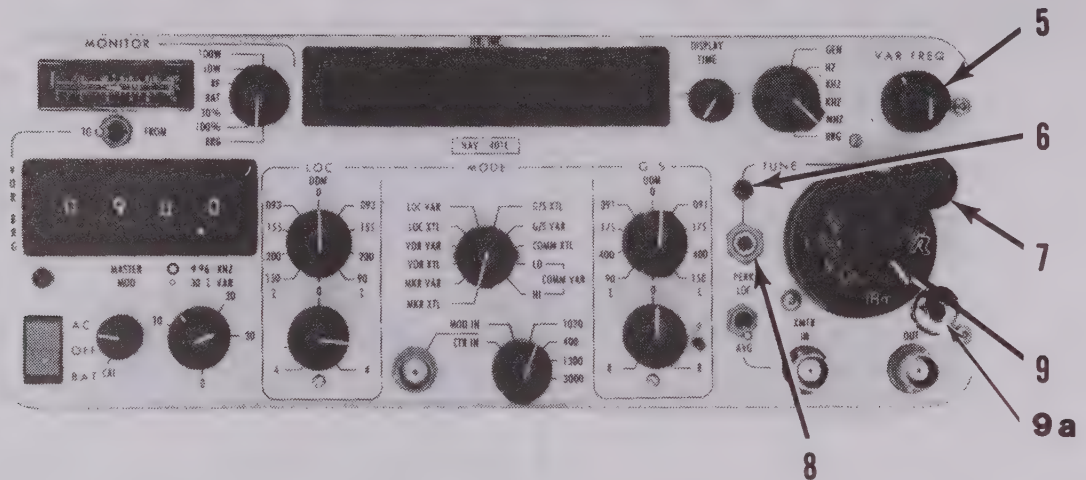


Fig. 3-3

| CONTROL/INDICATOR/CONNECTOR            | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5. (Cont.) Variable Frequency Controls | <p><u>Phase Lock Circuit.</u> Phase Lock Circuit is activated by turning the Fine Variable Frequency Control full CCW, into the detent position. Phase lock can be obtained every 25 kHz in variable frequency modes, except for G/S. G/S frequencies are phase locked in 50 kHz increments.</p> <p>Coarse Variable Frequency Control is used to select desired phase locked frequencies. Phase lock is indicated by proper count on the Frequency Counter (31). It is necessary to adjust for phase locked steps since pull-in range of phase lock circuit is less than 25 kHz. A phase lock on any frequency other than 25 or 50 kHz steps is not valid and will have severe frequency modulation (FM).</p> <p><u>NOTE</u></p> <p>Variable Frequency Oscillator should not be adjusted to a frequency within <math>\pm 5</math> kHz of an XTAL frequency to avoid interaction between oscillator circuits.</p> |

| CONTROL/INDICATOR/CONNECTOR  | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6. Tune Indicator            | Indicates proper Signal Generator tuning. Tune Indicator is extinguished when Generator is properly tuned.                                                                                                                                                                                                                                                                                                       |
| 7. Tune Control              | Adjusts Signal Generator for optimum tuning. It must be readjusted whenever a different frequency band is used or when Variable Frequency Controls (5) change frequency more than a few MHz in any one band. Tune Control should also be adjusted whenever Attenuator (9) is set for an output level from -15 dBm to max output level available, or whenever setting of Attenuator is changed within this range. |
| 8. Fine Tune Switch          | Fine tunes the Transmitter when tuning is within fine tune range and the Tune Indicator (7) is extinguished. When Fine Tune Switch is pressed, Tune Control (6) is adjusted for a minimum indication on Monitor Meter (29).                                                                                                                                                                                      |
| 9. Output Attenuator Control | Used to adjust RF level of Signal Generator Output at the RF Output Connector (10) into a 50 $\Omega$ load. Attenuator Dial is calibrated in -dBm or dB below 1 mW. The dial is accurate for output levels below -30 dBm. An Attenuator Correction Chart is included with each instrument. Also included is a chart converting -dBm to soft microvolts.                                                          |
|                              | <p><u>NOTE</u></p> <p><u>Soft Microvolts</u> - microvolts as measured with 50<math>\Omega</math> loading.</p> <p><u>Hard Microvolts</u> - microvolts as measured through a 6 dB pad, into 50 Ohms.</p>                                                                                                                                                                                                           |

Table 3-4 (Cont.)

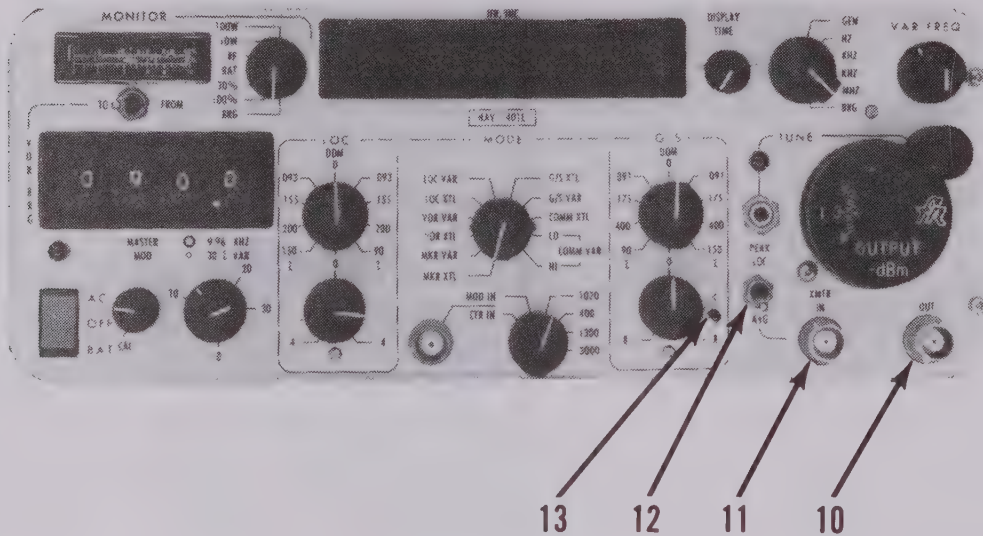


Fig. 3-4

| CONTROL/INDICATOR/CONNECTOR            | FUNCTION                                                                                                                                                                                                                                                               |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9a. A-100 Amp Voltage Supply Connector | Provides power supply voltage for A-100 Amp.                                                                                                                                                                                                                           |
|                                        | <b>CAUTION</b>                                                                                                                                                                                                                                                         |
|                                        | CONNECTOR IS NOT TO BE USED FOR ANY AUXILIARY EQUIPMENT EXCEPT THE A-100 AMP.                                                                                                                                                                                          |
| 10. RF Output Connector                | Provides Attenuated Signal Generator Output to equipment under test. This connector is diode protected against a COMM Transmitter being accidentally keyed, but steps should be taken to make sure than keying does not occur. Output is source terminated in 50 Ohms. |
| 11. COMM Transmitter Input Connector   | Input to Monitor Meter (29). It is connected with a 50Ω cable to a COMM Transmitter for power and frequency measurement purposes. Power indicated is either peak or average power. COMM Transmitter frequency is indicated on Digital Display (31) with Counter        |

| CONTROL/INDICATOR/CONNECTOR                    | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11. (Cont.) COMM Transmitter Input Connector   | <p>Mode Switch (3) in Hz, kHz, kHz, or MHz positions. An internal 25 dB pad is used in series with Power Monitor Circuit.</p> <p style="text-align: center;"><u>NOTE</u></p> <p>See SECTION 1, Technical Summary for Power Meter input power vs. time requirements.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 12. AVG/PEAK LOC XMTR ON Switch                | <p>Selects function of Power Meter (29). In PEAK position, the Power Meter indicates peak power amplitude of a COMM Transmitter with modulation applied. Peak Position also provides output from the separate Localizer Transmitter simultaneously with the Glide Slope signal, with Frequency Mode Switch (1) in the G/S XTAL position (for checking Autopilots or Course Computers).</p> <p>In AVG position, Power Meter indicates average RF power of a COMM Transmitter and disregards power changes due to proper modulation.</p>                                                                                                                                                                       |
| 13. 90/150 Hz Variable Phase ( $\phi$ ) Switch | <p>When Variable Phase (<math>\phi</math>) Switch is depressed, phase of 150 Hz tone can be varied in <math>5^{\circ}</math> steps by use of VOR Bearing Select Switches (27). Normally, 150 and 90 Hz tones used for LOC and G/S modulation are phase-locked together. If VOR Bearing Select Switches are set to <math>000.0^{\circ}</math>, depressing Variable Phase (<math>\phi</math>) Switch produces no change of phase. For each <math>1^{\circ}</math> step of VOR Bearing Select Switch, 150 Hz tone is shifted <math>+5^{\circ}</math> relative to the 90 Hz tone. 90 Hz tone always remains constant in phase with respect to <math>000.0^{\circ}</math> VOR Bearing Select Switch position.</p> |

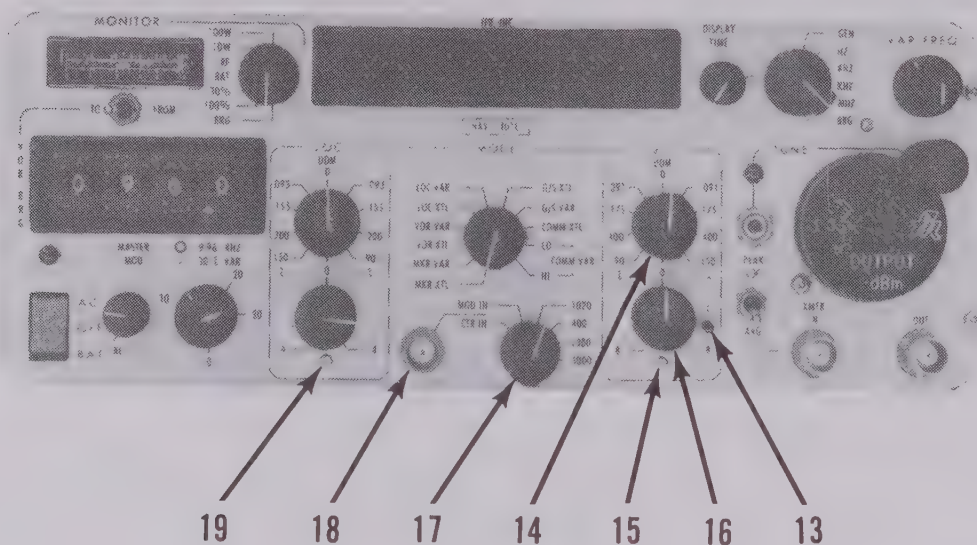


Fig. 3-5

| CONTROL/INDICATOR/CONNECTOR                            | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13. (Cont.) 90/150 Hz Variable Phase ( $\phi$ ) Switch | When 24° VOR Bearing is selected, 90 and 150 Hz tones are at their original phase relationships. When a 12° VOR Bearing is selected, amplitude summation of the 90 and 150 Hz tones is at maximum magnitude.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 14. Glide Slope DDM Control                            | <p>Selects amount of G/S pointer deviation on ILS Indicator under test. Calibrations in DDM (Difference in Depth of Modulation) represent standard deflection, full scale, and greater than full scale deflections. CW rotation of control gives upward deflection.</p> <p>In either 90 Hz or 150 Hz positions, the opposite tone is deleted and selected tone is at the same level as the on-course value (40%) so that a flag test can be made. Localizer DDM Control (21) should not be in the 90 or 150 Hz position when using Glide Slope function. This would cause either 90 or 150 Hz tone to be deleted by LOC DDM Control (21).</p> |

| CONTROL/INDICATOR/CONNECTOR                                     | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14. (Cont.) Glide Slope DDM Control                             | Continuous Wave (CW) operation can be obtained by placing G/S DDM Control (14) on 150 Hz and LOC DDM Control (21) on 90 Hz or vice versa.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 15. Glide Slope Centering Adjust Control                        | Varies the amplitude of 90 Hz tone and is used as an exact course centering control for Glide Slope modulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 16. Glide Slope Variable DDM Control                            | Continuously varies G/S pointer deflection from 0.8 DDM, down through 0 DDM to 0.8 DDM up. CW rotation of this control gives upward pointer deflection. G/S DDM Control (14) must be in arrow position (index mark down, directly toward G/S Variable DDM Control).                                                                                                                                                                                                                                                                                                     |
| 17. Tone Select Switch                                          | <p>Selects modulation input to internal Signal Generator or input to the Counter. In the MOD IN position, Modulation Input/External Frequency Counter Input Connector (18) is used as input to the Signal Generator. In any of four tone positions, a tone is selected to modulate various frequency bands selected by the Frequency Mode Switch (1). Glide Slope band cannot be externally modulated.</p> <p>When CTR (Counter) IN position is selected, Modulation Input/External Frequency Counter Input Connector (18) is used as input to the Digital Counter.</p> |
| 18. Modulation Input/External Frequency Counter Input Connector | External input to the Counter or external input to the Signal Generator. See paragraphs on Counter Mode Switch (3) and Tone Select Switch (17) for further information.                                                                                                                                                                                                                                                                                                                                                                                                 |
| 19. Localizer Centering Adjust                                  | Varies amplitude of 90 Hz tone and is used as an exact course centering control for Localizer modulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

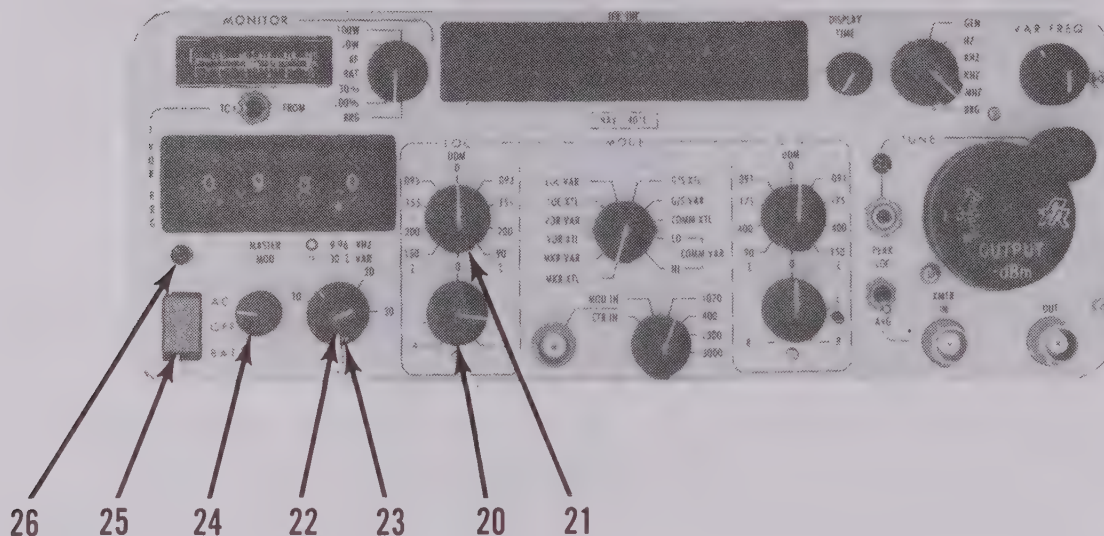


Fig. 3-6

| CONTROL/INDICATOR/CONNECTOR        | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20. Localizer Variable DDM Control | Continuously varies LOC pointer deflection from 0.4 DDM left through 0 DDM to 0.4 DDM right. CW rotation of 0 control gives right pointer deflection. LOC DDM Control (21) must be in arrow position (index mark down, directly toward LOC Variable DDM Control).                                                                                                                                                                                                                                                                                                   |
| 21. Localizer DDM Control          | <p>Selects amount of deviation of LOC pointer of an ILS Indicator under test. Calibrated in DDM, switch positions correspond to standard deflection, full scale, and greater than full scale deflections.</p> <p>In either 90 or 150 Hz position, the opposite tone is deleted and selected tone is at the same level as the on course value (20%) so that a flag test can be made. The G/S DDM Control (14) should not be in the 90 or 150 Hz position when using the Localizer function. This would cause the 90 or 150 Hz tone to be deleted by G/S control.</p> |

| CONTROL/INDICATOR/CONNECTOR         | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 21. (Cont.) Localizer DDM Control   | Continuous wave (CW) operation can be obtained by placing G/S DDM Control (14) on 150 Hz and LOC DDM Control (21) in 90 Hz position or vice versa.                                                                                                                                                                                                                                                                                                            |
| 22. 30 Hz VAR Level Control         | Changes percentage of modulation of 30 Hz VAR tone of VOR Composite Signal from 0 to 30%. It reaches 30% when knob is turned past the 30% line to the stop.                                                                                                                                                                                                                                                                                                   |
| 23. 9960 Hz REF Level Control       | Changes percentage of modulation of 9.960 kHz tone of VOR Composite Signal from 0 to 30%. It reaches 30% when the knob is turned past 30% line to the stop.                                                                                                                                                                                                                                                                                                   |
| 24. Master Modulation Level Control | <p>Controls modulation level of all modulating tones. In CAL (detent) position (full ccw), modulation levels of each type of signal (LOC, G/S, etc.) are fixed at their proper values of 20%, 30%, 40%, 95%, etc.</p> <p>In other than CAL position, control varies level of modulation of any signal from 0 to approximately twice normal level for that signal. For example, VOR IDENT tone is 30% in CAL position, and 0 to 60% in variable operation.</p> |
| 25. AC/Battery Power Switch         | Controls power to NAV-401L. It is a three position, center off switch. When AC is selected, test set is powered from a.c. line. When switch is depressed to BATT, which is a momentary position battery timer is activated. Test set will now operate on battery power until timer turns test set off, or until AC/Battery Power Switch is again depressed to BATT position. Time limit for battery timer is from 6 to 10 minutes.                            |
| 26. Power On Indicator              | Illuminates when ac or battery power is applied to the set.                                                                                                                                                                                                                                                                                                                                                                                                   |

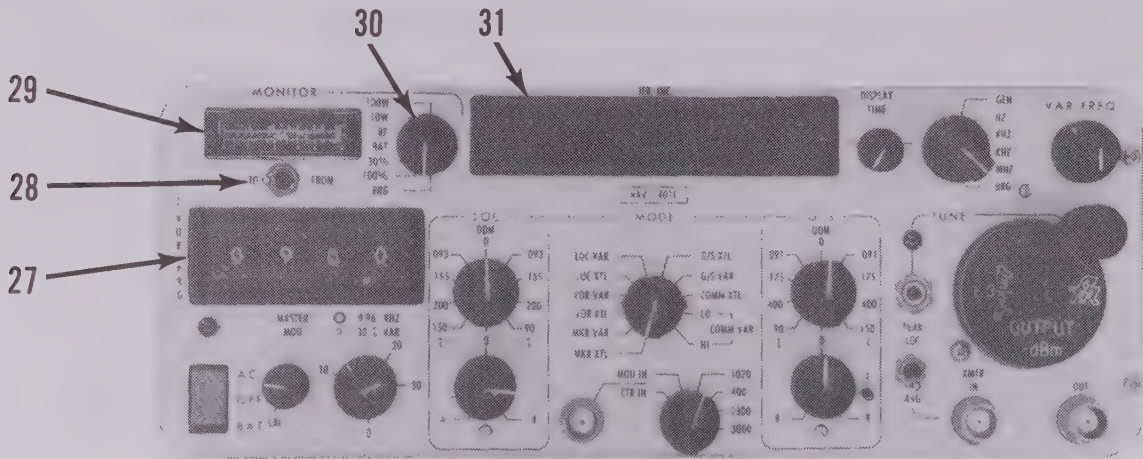
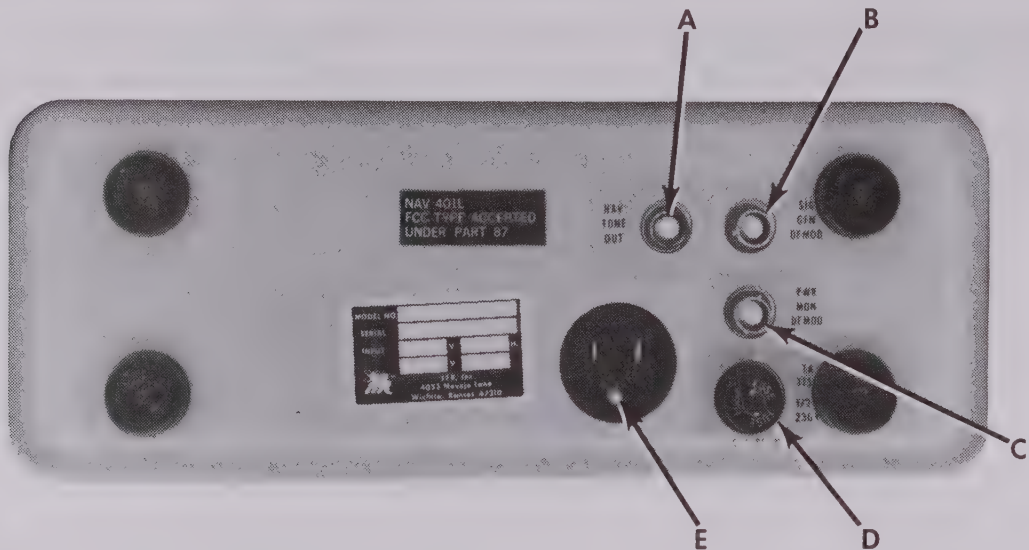


Fig. 3-7

| CONTROL/INDICATOR/CONNECTOR     | FUNCTION                                                                                                                                                                                                        |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27. VOR Bearing Select Switches | Four thumbwheel switches select VOR Bearing that is to be simulated by the NAV-401L. The Hundreds Digit Thumbwheel Switch (on left) is stopped at 3. Bearing indications from 360 through 399.9° are not valid. |
| 28. VOR Bearing TO/FROM Switch  | Changes selected VOR Bearing to reciprocal bearing for flag tests, etc.                                                                                                                                         |
| 29. Monitor Meter               | Provides analogue indication of RF power, Signal Generator RF Output Level, battery voltage, percent modulation of Signal Generator, and indication at 90° that VOR bearing circuitry is functioning properly.  |

| CONTROL/INDICATOR/CONNECTOR              | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>30. Monitor Meter Function Switch</p> | <p>Selects Monitor Meter function. COMM Transmitter power is measured on two scales: 0-10 Watts and 0-100 Watts. RF position is used to indicate proper RF leveling of Signal Generator. In BATT position, the 0 to 30% scale is used to read battery voltage. Less than 12.0 V indicates a discharged battery. A fully charged battery should indicate more than 15 V.</p> <p>30% and 100% switch positions are used to measure modulation level of Signal Generator.</p> <p>BRG switch position allows VOR Generator to be checked at 90°. Center of the band indicates a 0° bearing error. Left and right meter scale limits indicate VOR Bearing errors of <math>\pm 0.5\%</math>.</p> |
| <p>31. Digital Display</p>               | <p>Provides digital readout of: Selected VOR Bearing, Internal Generator frequency, external signal source frequency, or COMM Transmitter frequency. Function displayed is controlled by Counter Mode Switch (3). For details of operation, see paragraphs on Counter Mode Switch (3) and Display Time Control (2).</p>                                                                                                                                                                                                                                                                                                                                                                    |



| REAR PANEL<br>CONTROL/INDICATOR/CONNECTOR        | FUNCTION                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A. NAV Tones Demodulated Output Connector        | Provides audio output used to test VOR Bearing Circuits or Deviation Circuits of LOC and G/S NAV Receivers. Output level is varied by use of Master Mod Control (24) from approximately 0 to 7 Vp-p into 1000 ohms. The connector also provides access to the audio modulation of MARKER and COMM signals. The connector is internally connected to the NAV-401L Modulator. |
| B. Signal Generator Demodulated Output Connector | Provides demodulated output of Signal Generator. This output is to be used as a monitoring capability and is not intended to feed VOR and ILS Converters. If output voltage available is adequate and the approximately +4.25 Vdc. component is not objectionable, the output can be used to drive a Converter.                                                             |

| REAR PANEL<br>CONTROL/INDICATOR/CONNECTOR              | FUNCTION                                                                                                                                                                                 |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C. COMM Transmitter<br>Demodulated Output<br>Connector | Provides access to demodulated<br>output of a COMM Transmitter. This<br>may be used to display modulation<br>on an Oscilloscope or to listen to<br>modulation via an External Amplifier. |
| D. Fuseholder                                          |                                                                                                                                                                                          |
| E. AC Power Connector                                  |                                                                                                                                                                                          |
|                                                        |                                                                                                                                                                                          |

Table 3-4 (Cont.)

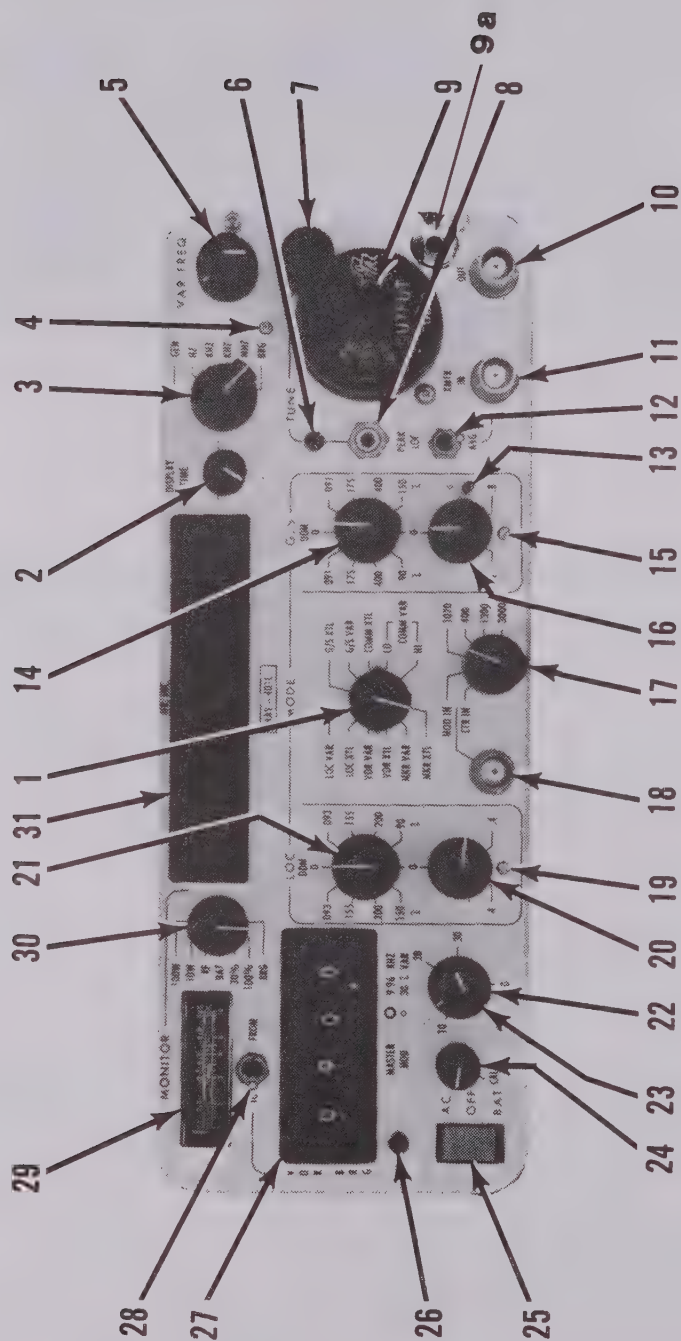


Fig. 3-9 NAV-401L Front Panel Controls, Indicators and Connectors (all)

## 1. MARKER OPERATION

|                                    |                                                                                                                                                                                             |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitor Meter & Switch (29) & (30) | RF - To verify proper leveling of Signal Generator.<br><br>100% - Use to verify 95% modulation of Signal Generator.                                                                         |
| Counter Mode Switch (3)            | GEN - To read out frequency of Generator in crystal or Variable modes.                                                                                                                      |
| Frequency Mode Switch (1)          | MKR XTAL - Mandatory in ramp operation; used on bench for standard Marker center frequency.<br><br>MKR VAR - Useful to check receiver bandwidths, etc. Can be phase-locked in 25 kHz steps. |
| VAR Freq Controls (5)              | Use as necessary in MKR VAR to check bandwidth of Receiver.                                                                                                                                 |
| Tune Controls (7) & (8)            | Tune Generator output for Tune Indicator (6) off, and dip on Monitor Meter (29).                                                                                                            |
| Output Attenuator (9)              | Use as necessary to establish receiver sensitivities.                                                                                                                                       |
| RF Out Connector (10)              | Connect to RECEIVER ANTENNA Connector, or attach Antenna in ramp operation.                                                                                                                 |
| Tone Select Switch (17)            | Select tone - 1020 (Ident tone) 400, 1300, 3000 Hz as desired.                                                                                                                              |
| Master Mod Level Control (24)      | Set to CAL for 95% or variable from 0 to 98%.                                                                                                                                               |
| Power Switch (25)                  | AC or Battery as desired.                                                                                                                                                                   |

Table 3-5 Typical Test Control Settings

## 2. VOR OPERATION

|                                    |                                                                                                                                                                                                                               |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitor Meter & Switch (29) & (30) | <p>RF - To verify proper leveling of Signal Generator.</p> <p>30% or 100% - Used to verify or set 30% modulation of each VOR modulating tone.</p> <p>BRG - Use to verify operation of bearing signal at 90° (Internally).</p> |
| Counter Mode Switch (3)            | GEN - To read out frequency of Generator in crystal or variable modes.                                                                                                                                                        |
| Frequency Mode Switch (1)          | VOR XTAL - Mandatory in ramp operation; used on bench for a very stable channel center frequency.                                                                                                                             |
|                                    | VOR VAR - Can be phase-locked in 25 kHz steps for all channel bench operation or to check receiver bandwidths, etc.                                                                                                           |
| VAR Freq Controls (5)              | Use in VOR VAR Mode to change VOR frequency either in 25 kHz steps or to continuously sweep frequency.                                                                                                                        |
| Tune Controls (7) & (8)            | Tune Generator output for Tune Indicator (6) out and dip on meter (29).                                                                                                                                                       |
| Output Attenuator (9)              | Use as necessary to establish receiver sensitivities.                                                                                                                                                                         |
| RF Out Connector (10)              | To Receiver Antenna Connector, or attach Antenna in ramp operation.                                                                                                                                                           |
| Tone Select Switch (17)            | Select IDENT tone - 1020 Hz (or others if desired)                                                                                                                                                                            |
| 30 Hz VAR Level Control (22)       | Use to vary the modulation level of the 30 Hz component from 0 to 30%.                                                                                                                                                        |
| 9.96 kHz REF Level Control (23)    | Use to vary the modulation level of the 9.96 kHz component from 0 to 30%.                                                                                                                                                     |

|                                 |                                                                                        |
|---------------------------------|----------------------------------------------------------------------------------------|
| Master Mod Level Control (24)   | Set to CAL for 30% each VOR tone or variable from 0 to 60% each tone.                  |
| Power Switch (25)               | AC or Battery as desired.                                                              |
| VOR BRG Select Switches (27)    | To bearing desired for radial testing and alignment.                                   |
| VOR Bearing TO/FROM Switch (28) | Use to achieve exact reciprocals of bearings selected and for flag test of Indicators. |

### 3. LOC OPERATION

|                                    |                                                                                                                                                                                                                                     |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitor Meter & Switch (29) & (30) | <p>RF - To verify proper leveling of Signal Generator.</p> <p>30% - Verify or set 20% modulation of each modulating tone and set course centering.</p>                                                                              |
| Counter Mode Switch (3)            | GEN - To read out frequency of Generator in crystal or variable mode.                                                                                                                                                               |
| Frequency Mode Switch (1)          | <p>LOC XTAL - Mandatory in ramp operation: used on bench for a very stable channel center frequency.</p> <p>LOC VAR - Can be phase-locked in 25 kHz steps for all channel bench operation or to check receiver bandwidths, etc.</p> |
| VAR Freq Controls (5)              | Use in LOC VAR mode. Change LOC frequency either in 25 kHz steps or to continuously sweep frequency.                                                                                                                                |
| Tune Controls (7) & (8)            | Tune Generator output for Tune Indicator (6) out and dip on meter (29).                                                                                                                                                             |
| Output Attenuator (9)              | Use as necessary to establish receiver sensitivities.                                                                                                                                                                               |
| RF Out Connector (10)              | To Receiver Antenna Connector, or attach Antenna in ramp operation.                                                                                                                                                                 |
| Tone Select Switch (17)            | Select IDENT Tone - 1020 Hz (or others if desired).                                                                                                                                                                                 |

|                               |                                                                                                                                           |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| LOC DDM Control (21) & (20)   | Stepped - Used for precise amounts of deflection and flag tests.<br><br>VAR - Used for checking Auto-Pilot Servos, meter stickiness, etc. |
| Master Mod Level Control (24) | Set to CAL for 20% each course tone and 30% Ident Tone, or variable 0 to 40% each course tone and 0 to 60% Ident Tone.                    |
| Power Switch (25)             | AC or Battery as desired.                                                                                                                 |

## 4. G/S OPERATION

|                                    |                                                                                                                                                                                                                                  |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitor Meter & Switch (29) & (30) | RF - To verify proper leveling of Signal Generator.<br><br>100% - Verify or set 40% modulation of each modulating tone and set course centering.                                                                                 |
| Counter Mode Switch (3)            | GEN - To read out frequency of Generator in crystal or variable mode.                                                                                                                                                            |
| Frequency Mode Switch (1)          | G/S XTAL - Mandatory in ramp operation; used on bench for a very stable channel center frequency.<br><br>G/S VAR - G/S can be phase locked in 50 kHz steps for all channel bench operation or to check receiver bandwidths, etc. |
| VAR Freq Controls (5)              | Use in G/S VAR mode to change G/S frequency either in 50 kHz steps or to continuously sweep frequency.                                                                                                                           |
| Tune Controls (7) & (8)            | Tune Generator output for Tune Indicator (6) off and dip on meter (29).                                                                                                                                                          |
| Output Attenuator (9)              | Use as necessary to establish receiver sensitivities.                                                                                                                                                                            |
| RF Out Connector (10)              | To Receiver Antenna Connector, or to attach Antenna in ramp operation.                                                                                                                                                           |

|                               |                                                                                                                                                 |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| G/S DDM Control (14) & (16)   | <p>Stepped - Used for precise amount of deflection and flag tests.</p> <p>VAR - Used for checking auto-pilot servos, meter stickiness, etc.</p> |
| Master Mod Level Control (24) | Set to CAL for 40% each course tone, or variable 0 to 80%.                                                                                      |
| Power Switch (25)             | AC or Battery as desired.                                                                                                                       |
| AVG/PEAK LOC XMTR Switch (12) | <p>LOC position if simultaneous G/S and LOC output desired.</p> <p>NOTE: Frequency Mode Switch should be in G/S XTAL position.</p>              |

5. COMM OPERATION (RECEIVER TESTS)

|                                      |                                                                                                                                                                                                                                                                    |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monitor Meter and Switch (29) & (30) | <p>RF - To verify proper leveling of signal Generator.</p> <p>30% or 100% - Verify or set 30% sine-wave modulation tone.</p>                                                                                                                                       |
| Counter Mode Switch (3)              | GEN - To read out frequency of Generator in crystal or variable mode.                                                                                                                                                                                              |
| Frequency Mode Switch (1)            | <p>COMM XTAL - Mandatory in ramp operation; used on bench for a very stable channel center frequency.</p> <p>COMM VAR LO - Use to check COMM Receiver channels 118.0 to 135.95 MHz.</p> <p>COMM VAR HI - Use to check COMM Receiver channels 134.0 to 150 MHz.</p> |
| VAR Freq Controls (5)                | Use in COMM VAR modes to change COMM frequency in 25 kHz steps or to continuously sweep frequency.                                                                                                                                                                 |
| Tune Controls (7) & (8)              | Tune Generator output for Tune Indicator (6) out and dip on Meter (29).                                                                                                                                                                                            |
| Output Attenuator (9)                | Use as necessary to establish receiver sensitivities.                                                                                                                                                                                                              |

Table 3-5 (Cont.)

|                                       |                                                                                             |
|---------------------------------------|---------------------------------------------------------------------------------------------|
| RF Out Connector (10)                 | To Receiver Antenna Connector, or attach Antenna in ramp operation.                         |
| Tone Select Switch (17)               | Use to select tone frequency desired or for external modulation input (bench testing only). |
| MOD IN/EXT FREQ CTR IN Connector (18) | Use to apply external modulation to Signal Generator.                                       |
| Master Mod Level Control              | Set to CAL for 30% each tone selected or variable 0 to 60% modulation each tone.            |
| Power Switch (25)                     | AC or Battery as desired.                                                                   |

## 6. COMM OPERATION (TRANSMITTER TESTS)

|                                       |                                                                                                                                    |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Monitor Meter & Switch (29) & (30)    | 10W or 100W - Use to measure transmitter power.<br><br>CAUTION<br><br>Observe power versus time limits of power meter (SECTION I). |
| Counter Mode Switch (3)               | Hz, kHz - Use to measure Transmitter frequency - kHz, MHz, HF or VHF bands.                                                        |
| AVG/PEAK LOC XMTR Switch (12)         | Peak - Use to indicate increase in power during modulation.<br><br>Avg - Use to indicate Avg power only disregarding modulation.   |
| MOD IN/EXT FREQ CTR IN Connector (18) | Attach Whip Antenna for COMM frequency measurements in portable operation.                                                         |
| Tone Select Switch (17)               | To CTR IN position.                                                                                                                |
| Power Switch (25)                     | AC or Battery as desired.                                                                                                          |
| COMM XMTR IN Connector (11)           | Connect to COMM Transmitter output.                                                                                                |

THEORY OF OPERATION  
NAV-401L SECTION 4

1 Introduction.

1-1 This section gives information about the general theory of NAV-401L circuit operation. Descriptions of Glide Slope, Localizer, COMM, Marker, and VOR Ground Station simulation signal generation are followed by theories of various systems and modules.

2 Marker Signal Generation. (ref. Simplified Overall Block Diagram)

2-1 The signal used to simulate the ILS Inner, Middle and Outer Marker Beacons consists of RF modulated by the appropriate audio tone. Typical RF frequency used by the NAV-401L is 75 MHz.

2-2 Three Marker tones (400, 1300, and 3000 Hz) and 1020 Hz IDENT tone are generated on the Regulator-Timer Board (PC-2). Desired tone is selected by the Tone Select Switch (S7B). After passing through the Tone Select Switch, the selected tone is returned to PC-2 where it is converted from a square wave to a low distortion sine wave. This tone output is applied to the 30 Hz Sine Board (PC-4) via Tone Select Switch (S7A). On PC-4, the Marker tone may be combined with VOR, COMM, or Localizer modulation. In Marker mode, only Marker tone is present. Marker tone is passed through Frequency Mode Switch (S701) to Combination Sine Board (PC-3). On PC-3, the Marker tone is processed through a fixed or a variable level buffer amplifier.

2-3 The output of the buffer amp on PC-3 is applied to the Audio Signal Input of the Modulator and Power Amplifier (Assy. 6) and is used to modulate the RF output.

2-4 The Marker (or IDENT) tone output of the Combination Sine Board is also supplied through a separate buffer amp to the NAV Tones Output Connector (J1102). The Modulator and Power Amplifier provides a demodulated tone output which is available at the Signal Generator Demodulated Output Connector (J1104). This signal is  $180^{\circ}$  out of phase with the signal at the NAV Tones Output Connector.

3 COMM Signal Generation. (ref. Simplified Overall Block Diagram)

3-1 COMM signal generation is very similar to Marker signal generation. A different RF frequency is used (126.9 MHz typ.) and percent of RF modulation is different.

- 4 VOR Signal Generation. (ref. Simplified Overall Block Diagram)
- 4-1 The 30 Hz Variable and 30Hz Reference signals are generated on Bearing Logic PC Board (PC-5). When a VOR bearing other than  $0.0^{\circ}$  is selected on Bearing Selector Switches (S2), the 30 Hz VAR signal is phase shifted with respect to the 30 Hz REF signal.
- 4-2 Two 30 Hz square-wave VAR signals  $180^{\circ}$  out of phase are routed to 30 Hz Sine Board (PC-4) via TO/FROM Switch (S3). The 30 Hz REF signal is applied to PC-4 directly. On PC-4, 30 Hz VAR and REF signals are processed into low distortion sine waves. The 30 Hz REF signal is applied to the 9960 Hz Oscillator circuit on PC-4 where it is used to phase lock and frequency modulate the 9960 Hz signal. This produces a 30 Hz FM modulated, 9960 Hz signal with a  $\pm 480$  Hz deviation. The modulated 9960 Hz, and 30 Hz VAR signal are summed on PC-4. This composite VOR modulation signal is applied to Frequency Mode Switch (S701).
- 4-3 From the MODE Switch, the selected VOR modulation signal is applied to Combination Sine Board (PC-3). On PC-3, the VOR signal is processed through a fixed or a variable level buffer amplifier. The output of this buffer amp is applied to the Audio Signal Input of the Modulator and Power Amplifier (Assy. 6) where it is used to modulate the RF output.
- 4-4 The VOR modulation signal output of the Combination Sine Board is also supplied through a separate buffer amp to NAV Tones Output Connector (J1102). The Modulator and Power Amplifier provides a demodulated tone output which is available at the Signal Generator Demodulated Output Connector (J1104). This signal is  $180^{\circ}$  out of phase with the signal at the NAV Tones Output Connector.
- 5 Localizer and Glide Slope Signal Generation. (ref. Simplified Overall Block Diagram)
- 5-1 90 and 150 Hz tones for G/S and LOC are generated on Bearing Logic Board (PC-5). Circuitry of PC-5 allows the 150 Hz tone to be phase shifted with respect to the 90 Hz tone when the 90/150 Hz Variable Phase Switch (S9) is depressed and a bearing between  $0.0^{\circ}$  and  $360^{\circ}$  is selected on Bearing Select Switches (S2). Amount of phase-shift is controlled by the Bearing Select Switches.
- 5-2 The 90 and 150 Hz square-wave outputs of PC-5 are applied to Combination Sine Board (PC-3). The 90 and 150 Hz square-waves are converted to low distortion sine waves by sine synthesizing circuits on PC-3. The 90 Hz sine wave is applied to LOC and G/S Centering Controls (R4 & R6), routed back to PC-3 where the signal is buffered, and applied to LOC & G/S DDM Switches (S8 & S5). The 150 Hz sine wave is applied directly to LOC & G/S DDM Switches via a buffer.

- 5-3 The 90 and 150 Hz tones are summed at LOC and G/S DDM Switches and applied to 30 Hz Sine Board (PC-4). These LOC and G/S deviation signals are buffered on PC-4 and applied to Frequency Mode Switch (S701). The output of the MODE Switch is reapplied to PC-4 where it may be combined with MKR or IDENT tones (Localizer only). The G/S or LOC signal is then processed through a fixed or a variable buffer amplifier on PC-3.
- 5-4 Output of the buffer amp on PC-3 is applied to the Audio Signal Input of the Modulator and Power Amplifier (Assy. 6) where it is used to modulate the RF output.
- 5-5 The selected LOC or G/S deviation signal output of the combination Sine Board is also applied through a separate buffer amp to NAV Tones Output Connector (J1102). The Modulator P.A. provides a demodulated tone output which is available at Signal Generator Demodulated Output Connector (J1104). This signal is  $180^\circ$  out of phase with the signal at the NAV Tones Output Connector.
- 6 Bearing Generator. (ref. Simplified Bearing Generator Block Diagram)
- 6-1 VOR bearing is generated by a crystal-controlled digital counting system. All of the Circuitry (except the Bearing Select Switches) is located on Bearing Logic Board (PC-5). The 90 and 150 Hz LOC and G/S tones are also generated on the Bearing Logic Board as a side product of the bearing counters.
- 6-2 The clock signal is generated by crystal oscillator and a divider circuit on PC-5. Each clock pulse is equivalent to  $0.1^\circ$  of bearing. Clock pulses are applied to a counter that counts 3600 clock pulses and then resets to another count cycle. Gates and other logic circuit are used as count control for the counter. The output of the count control circuit is used as the 30 Hz reference square-wave output.
- 6-3 Four Bearing Select Switches (S2) select counts in the bearing counter corresponding to bearings from  $000.1^\circ$  to  $359.9^\circ$ . Switch outputs are summed together via a common gate and applied as a start pulse to a counter.
- 6-4 When the start pulse is applied, the counter begins counting clock pulses at a  $0.1^\circ$  rate. After 1800 pulses have been counted, a counter control circuit stops the clock input and resets the counter. Output of the  $180^\circ$  counter system is a 30 Hz square wave. It is delayed from the start of the 30 Hz Reference signal by the number of degrees selected on the VOR BRG SEL Switches. Two outputs are available  $180^\circ$  apart to simulate a TO or FROM signal.

- 6-5 90 and 50 Hz square waves are generated by picking off counts from the bearing counter and adding further divisions. By this method, the 90 and 150 Hz frequencies are both crystal controlled and phase locked together.
- 6-6 The phase relationship between 90 and 150 Hz tones can be varied by a special circuit. By using the reset from the 30 Hz VAR output signal, the 150 Hz tone can be stepped in 5° increments relative to the 90 Hz tone. VOR BRG SEL Switches are used to vary this phase relationship. Each 1° of bearing selected causes 5° of 150 Hz phase shift.
- 7 RF Section. (ref. Simplified RF Block Diagram)
- 7-1 All RF energy is generated by the Oscillator Assembly (Assy.5). Within the Assembly are five crystal-controlled oscillators and one variable-frequency oscillator. The variable-frequency oscillator is band switched to cover 72-78 MHz and 107-156 MHz bands. Crystal frequencies supplied as standard are those authorized for ramp use by the FAA. Special frequencies can be substituted if required.
- 7-2 The oscillator output is fed to the Modulator Power Amplifier Assembly (Assy. 6). Within the Modulator P.A. Assembly, the modulator and power amplifier are designed as a servo control system with the RF output controlled by the modulator.
- 7-3 All RF is amplified and fed through the power amplifier. There is no frequency change, except when operating in G/S mode. In G/S mode, the input carrier frequency is tripled in the output stage. All power amplifier circuits are broadtuned (except for the output stage). The amplifier output stage must be peaked for proper output by Front Panel Tune Control. Output from the final amplifier stage is fed directly to an Attenuator. The output of this attenuator is applied to a Diode Protect Block. This Block guards against damage to the Attenuator if a Transmitter is connected to the RF Output Connector.
- 7-4 RF at the attenuator input is detected and applied to the modulator input. Proper audio modulation is also applied to the Modulator and Power Amplifier after being buffered by an amplifier on Combination Sine PC Board (PC-3). The modulator-collector modulates the output stage of the power amplifier and requires a certain level of RF output to meet percentage modulation requirements and RF level output of the output stage. Each of five modes of operation requires a different detected voltage. This voltage is determined by five gain switches in the modulator. These switches are driven by Mode Control Lines from Frequency Mode Switch (S701).

- 7-5 The modulator output to the power amplifier may be routed to the Monitor Meter by the Tune Switch (S11). The power amplifier is in perfect tune when the command voltage from the modulator is minimum. Therefore; when the Tune Switch is depressed, the Tune control is adjusted for a dip on the Monitor Meter.
- 7-6 The modulator output is also applied to a Tune Indicator (L-2). This indicator is illuminated whenever the modulator requires more detected RF voltage than the power amplifier is tuned for. When the power amplifier is adjusted, Tune Indicator is not illuminated.
- 7-7 Output of the modulator input amplifier is sampled to give a direct percent of modulation measurement, and a relative indication of the power amplifier's tune condition. This is possible because the percentage of modulation is directly controlled by the modulator. Output of the modulator input amplifier is applied to three places. It is applied to the Combination Sine Board (PC-3) where it is used in the Modulation Monitor circuit and the RF Level Meter circuit. The output is applied to Signal Generator Demodulated Output Connector (J1104). The output is applied to Bearing Check Board (PC-1). During VOR operation, the modulation is demodulated to determine VOR Relative Bearing Error in the RF output (at 90° bearing only).
- 7-8 A separate Localizer Generator is turned on when AVG/PEAK-LOC XMTR Switch (S10) is in the PEAK-LOC position. The localizer generator frequency is chosen to pair with the 334.7 MHz (typ.) G/S XTL frequency. This frequency is fixed at 108.1 MHz. Audio from the LOC DDM Switch (S5) is applied to the Generator for output modulation. The Generator output level is approximately -15 to -20 dBm. This output is mixed with G/S XTL RF in the Diode Protect Block.
- 7-9 When Frequency Mode Switch (S701) is set to any Variable Frequency position, the Oscillator can be phase locked in 25 kHz increments, or operated completely free-running. The phase-lock circuit is located on Phase Lock/Power Monitor Assembly (Assy. 4). G/S is phase locked in 50 kHz increments.
- 7-10 In any mode but G/S, the reference frequency for phase lock is 250 Hz taken from the Counter. The oscillator frequency is taken from the ÷100 prescaler output and compared against the 250 Hz reference. The oscillator output frequency is set by Coarse Variable Frequency Control (R9). When the output frequency closely equals the nearest 25 kHz step, the oscillator frequency is locked to that 25 kHz step.

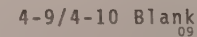
- 7-11 In G/S mode, the reference frequency for phase lock is 166 Hz, taken from the Counter. The G/S signal phase locks in 50 kHz steps.
- 7-12 When phase-lock operation is not desired, Coarse Variable Frequency Control (R9) gives very large frequency changes for any rotation and Fine Variable Frequency Control (R10) gives small frequency changes.
- 7-13 A COMM Transmitter can be connected to XMTR IN Connector (J2). Signals at this connector are applied to a 25 dB pad. The output of the pad is applied to the power monitor portion of Assembly 4. A monitoring circuit drives the Monitor Meter in one of two ranges, 0 to 10 W, or 0 to 100 W. The output of the Power Monitor is applied to Rear Panel COMM Transmitter Demodulated Output Connector (J1103). This allows the COMM audio to be observed on an Oscilloscope or listened to via an External Amplifier.
- 7-14 At the XMTR IN Connector (J2), a small sample of the RF is applied to the Counter to measure COMM Transmitter frequencies. The frequency may be displayed in any counter mode except GEN and BRG (Bearing).

#### 8 Counter Section. (ref. Simplified Counter Block Diagram)

- 8-1 All count inputs to the Counter (except Bearing Check) go through the Prescaler (Assy. 1). There are two inputs to the Prescaler. One from the Buffer Amplifier Assembly is used as the count for the internal generator. This count input is switched to pass through the Prescaler when Counter Mode Switch is in the GEN position.
- 8-2 The second input to the Counter is from Modulation Input/ External Frequency Counter Input Connector (J1). Also summed at this input is the XMTR IN Connector so that COMM transmitter frequencies may be measured. This count input is switched to pass through the Prescaler when Counter Mode Switch is in any position except GEN or BRG.
- 8-3 Both inputs to the Prescaler result in a direct count output and a  $\div 100$  prescaled output. Both of these outputs are applied to the Counter (PC-6) where the direct output is counted in the Hz and first kHz positions of the Counter Mode Switch. The  $\div 100$  output is counted in the GEN, second kHz, and MHz Counter Mode Switch positions.
- 8-4 With Counter Mode Switch in BRG position, duration of the count gate for the Counter is equal to the period of the 30 Hz Reference square wave from the Bearing Logic Board. The count input is from the Bearing Logic Board. This is the output of the  $0.1^0$  divider gated by VOR Bearing Select Switch output. A number of  $0.1^0$  clock pulses are applied to the counter that

- 8-4 (Cont.) correspond to the number of bearing degrees selected. The pulses are counted and displayed by the Counter with a resolution of  $0.1^{\circ}$ .
- 8-5 Counter clock pulses are generated by a 10 MHz XTAL oscillator. This oscillator is located on the Bearing Check Board. The oscillator output frequency is divided to 100 kHz ( $\div 100$ ) and applied to the Counter PC Board where it is further divided to gate times of 0.1 and 1.0 sec.
- 8-6 In G/S mode, the 0.1 sec. time base is divided by three. This effectively multiplies the input count by three. (In G/S mode, the oscillator frequency is multiplied by three in the output stage of the Power Amplifier.) Since power amplifier input to the Counter is taken from the input of the power amplifier, that count must be tripled so that the Counter displays the G/S frequency output of the power amplifier.
- 8-7 The minimum recommended operating voltage for the NAV-401L Display is 160 Vdc.
- 9 Monitoring Section. (ref. Monitoring Section Block Diagram)
- 9-1 Three monitoring circuits are located on PC-3. Battery voltage is monitored by one of them.
- 9-2 The signal generator demodulated output from the power amplifier is applied to PC-3. The dc level of this signal is sampled and applied to the Meter for an RF level indication. The demodulated output is also processed to determine the accurate percentage of modulation. Two modulation ranges are available, 0 to 30% and 0 to 100%.
- 9-3 Two monitor circuits are located on the Bearing Check Board (PC-1). The Power Monitor Assembly (Assy. 4) is applied to PC-1 where it is processed and applied to the Meter in two ranges. The two ranges are, 0 to 10 W and 0 to 100 W.
- 9-4 The other monitor circuit on PC-1 is the Bearing Check system. The signal generator demodulated output from the power amplifier is further demodulated and broken down to the two 30 Hz signals during VOR operation. The phase relationship of the 30 Hz REF and 30 Hz VAR is compared at  $90^{\circ}$  and an error signal is produced. That error voltage is applied to the Monitor Meter for bearing check information.
- 10 Power Section. (ref. Power Section Block Diagram)
- 10-1 The NAV-401L is powered by either an external a c source (115 or 240 Vac.), or an internal 13.75 V NICAD battery pack.

- 10-2 The Power Supply Assembly (Assy. 2) is located on the Rear Panel. A C power is converted to a lower voltage by a transformer. This a c is rectified to +20 Vdc whenever the NAV-401L is connected to an a c source. The +20 Vdc is applied continuously to the Battery Charging Circuit on Regulator-Timer PC Board (PC-2). Whenever the test set is connected to ac power, the NICAD battery pack is being charged. The battery charger is self-limiting. This causes a discharged battery to be charged at a high rate, and a fully-charged battery to be trickle charged. This self-limiting feature allows the set to be left on continuously when connected to ac.
- 10-3 During ac power operation, the +20 V is applied through AC/Battery Power Switch (S2) to PC-2 and the +5 Vdc Power Supply (Assy. 3). On PC-2, the +20 V is regulated to +11 V. This +11 V is used throughout the NAV-401L. Negative voltage developed by the +5 V Switching Regulator is applied to PC-2 and dropped to -6.2 V.
- 10-4 The +5 V Switching Regulator provides two sources of +5 V. One is used by the test set as a whole and the other (switched) is supplied to the counter circuitry.
- 10-5 When using battery power, a 6-10 minute timer does the actual power switching. The AC/Battery Power Switch turns the timer on, when the switch is depressed to BATT position. This applies battery voltage to the remainder of the power system in place of the +20 V used in ac operation. After approximately 6 to 10 minutes, the timer turns the set off. Pressing the AC/Battery Power Switch a second time to BATT position will turn off the timer and the test set.





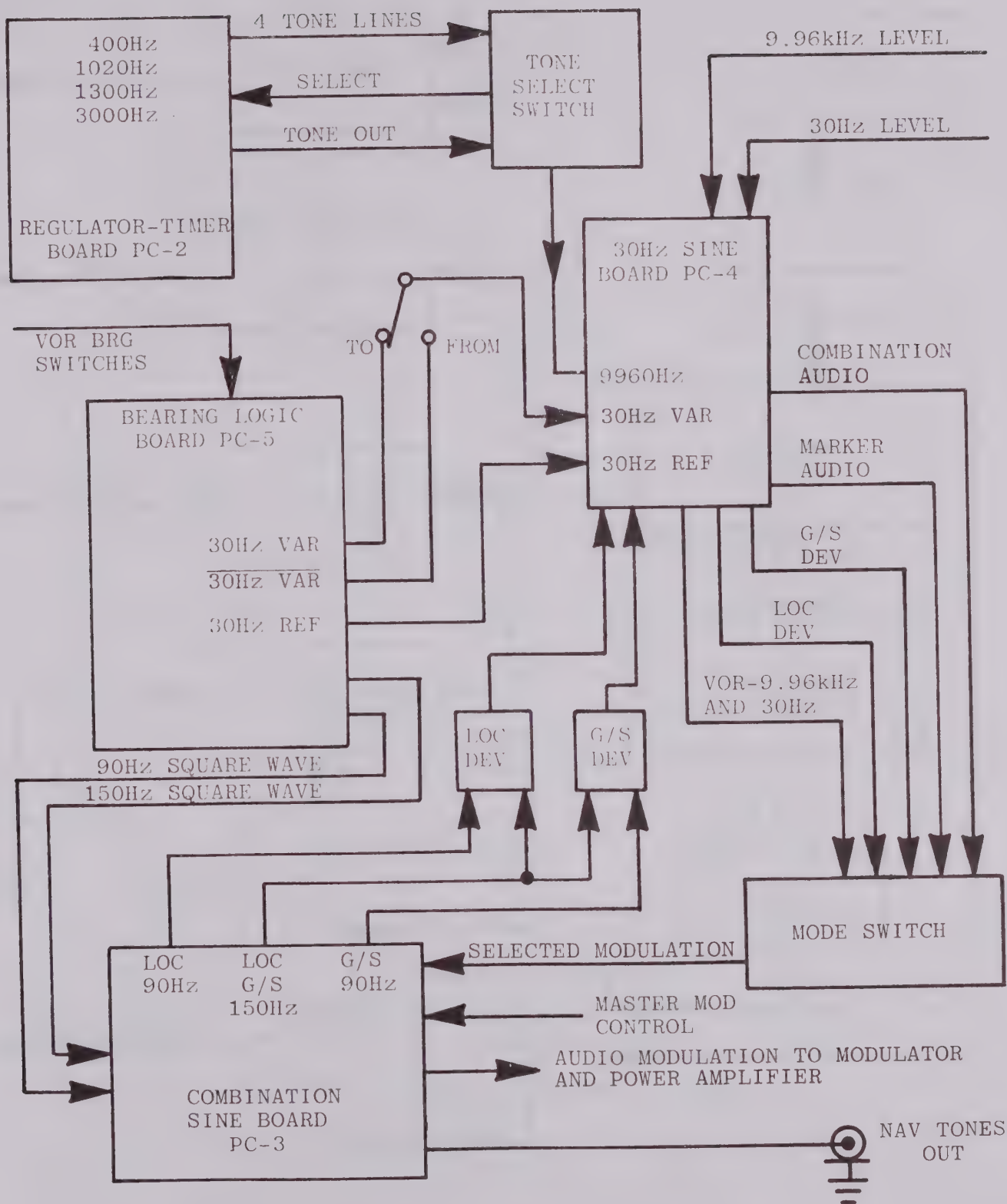


Fig. 4-2 Simplified Tone Generator Block Diagram

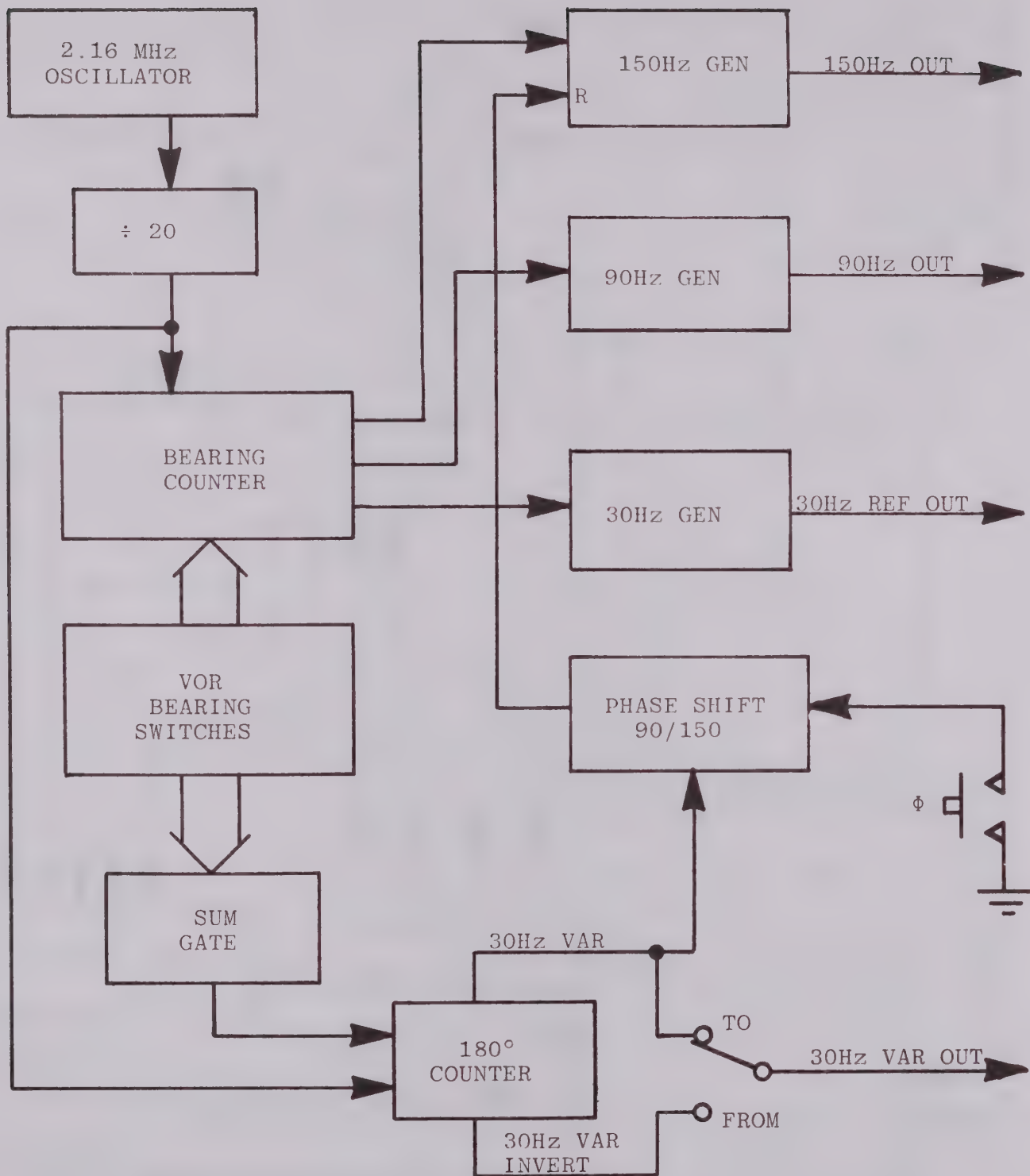


Fig. 4-3 Simplified Bearing Generator Block Diagram

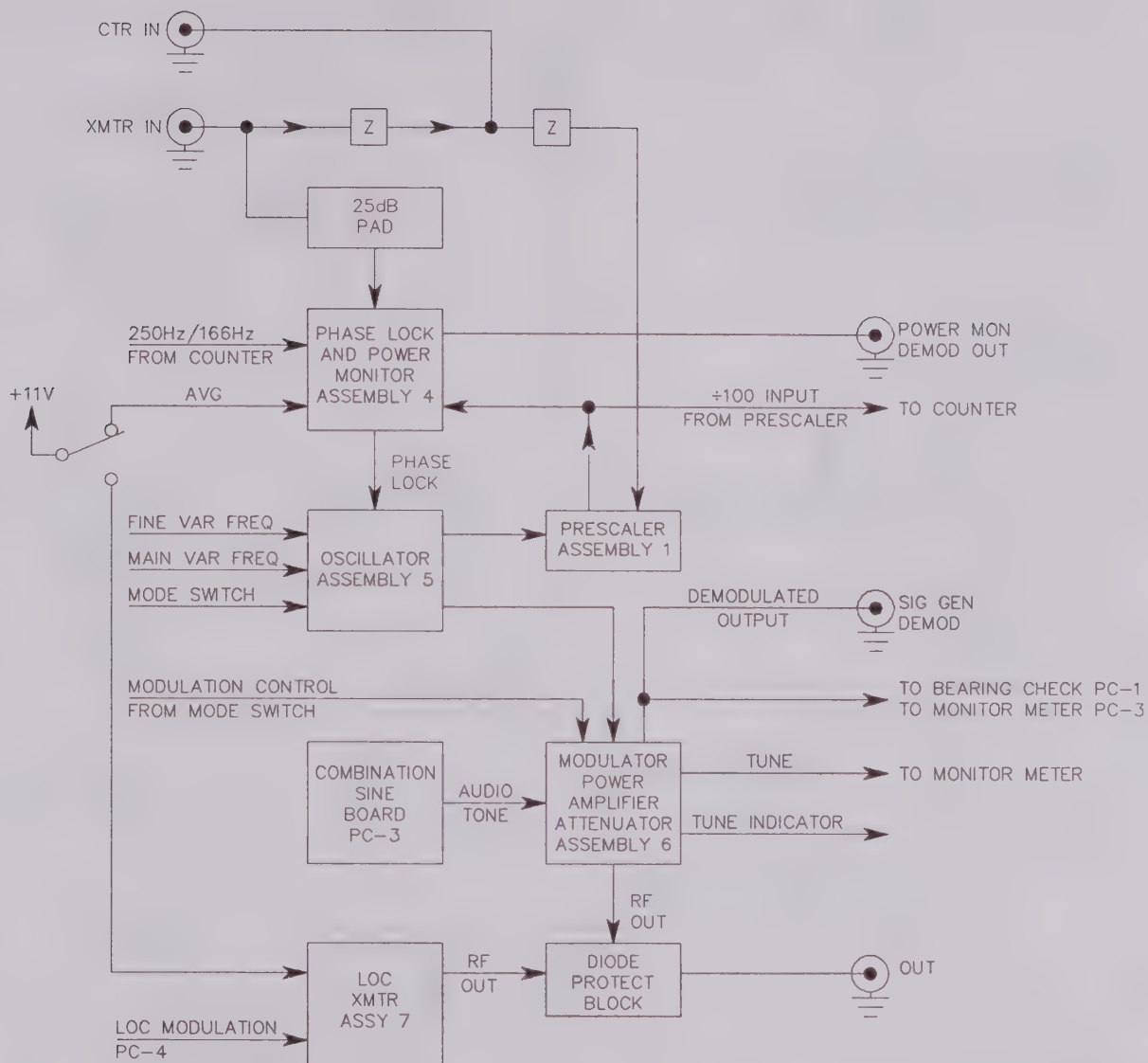


Figure 4-4 Simplified RF Generator Block Diagram

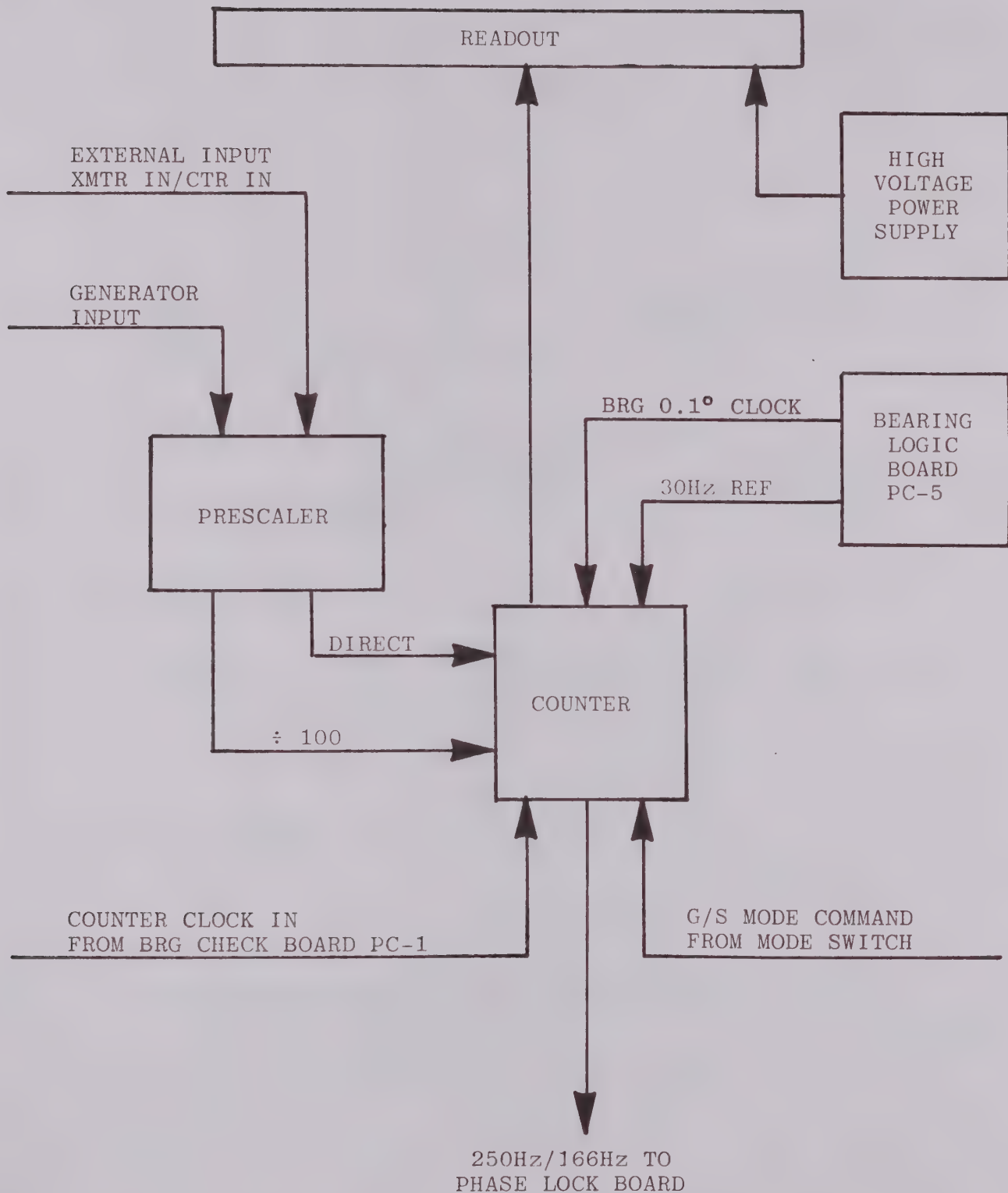


Fig. 4-5 Simplified Counter Block Diagram

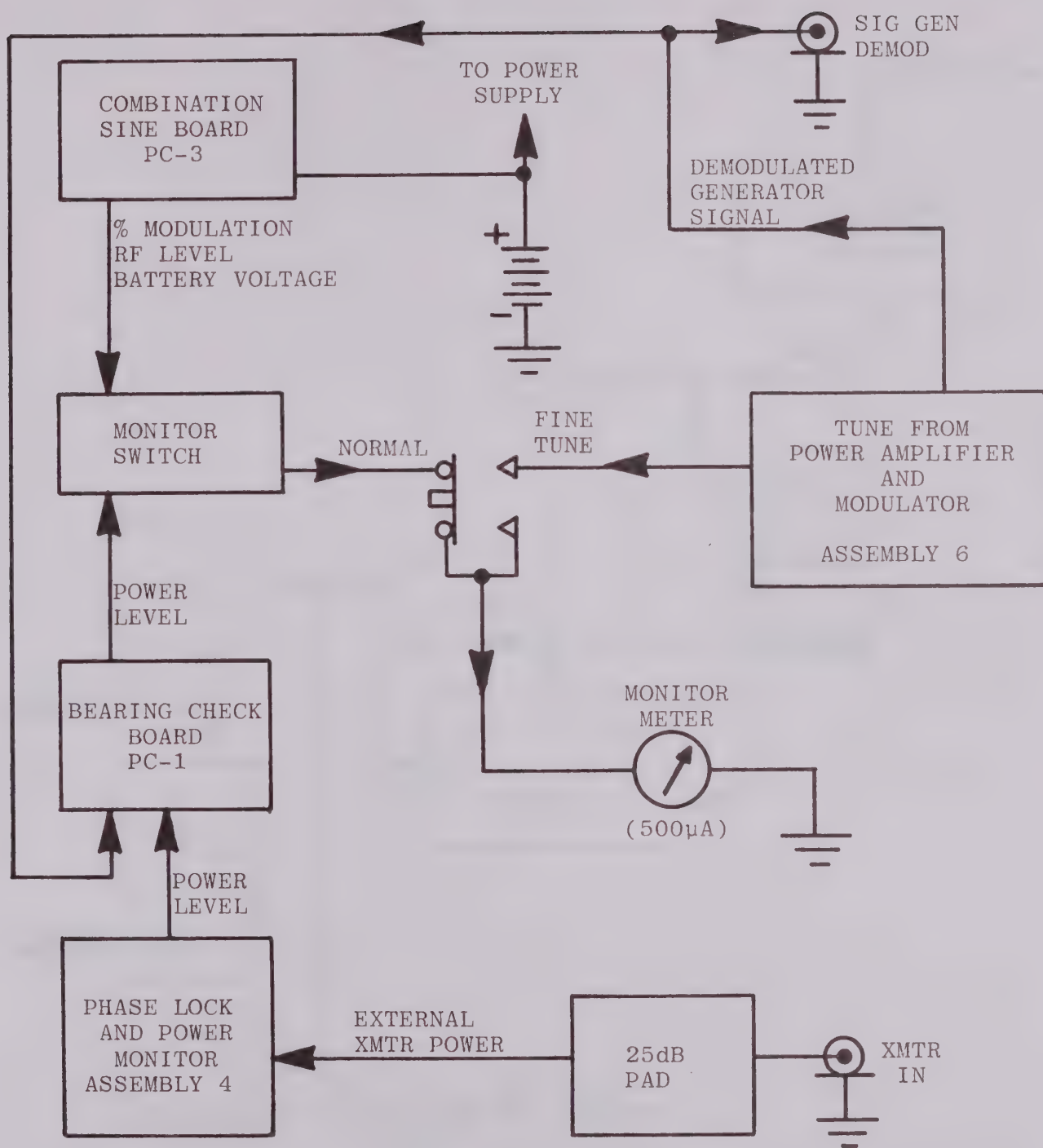


Fig. 4-6 Monitoring Section Block Diagram

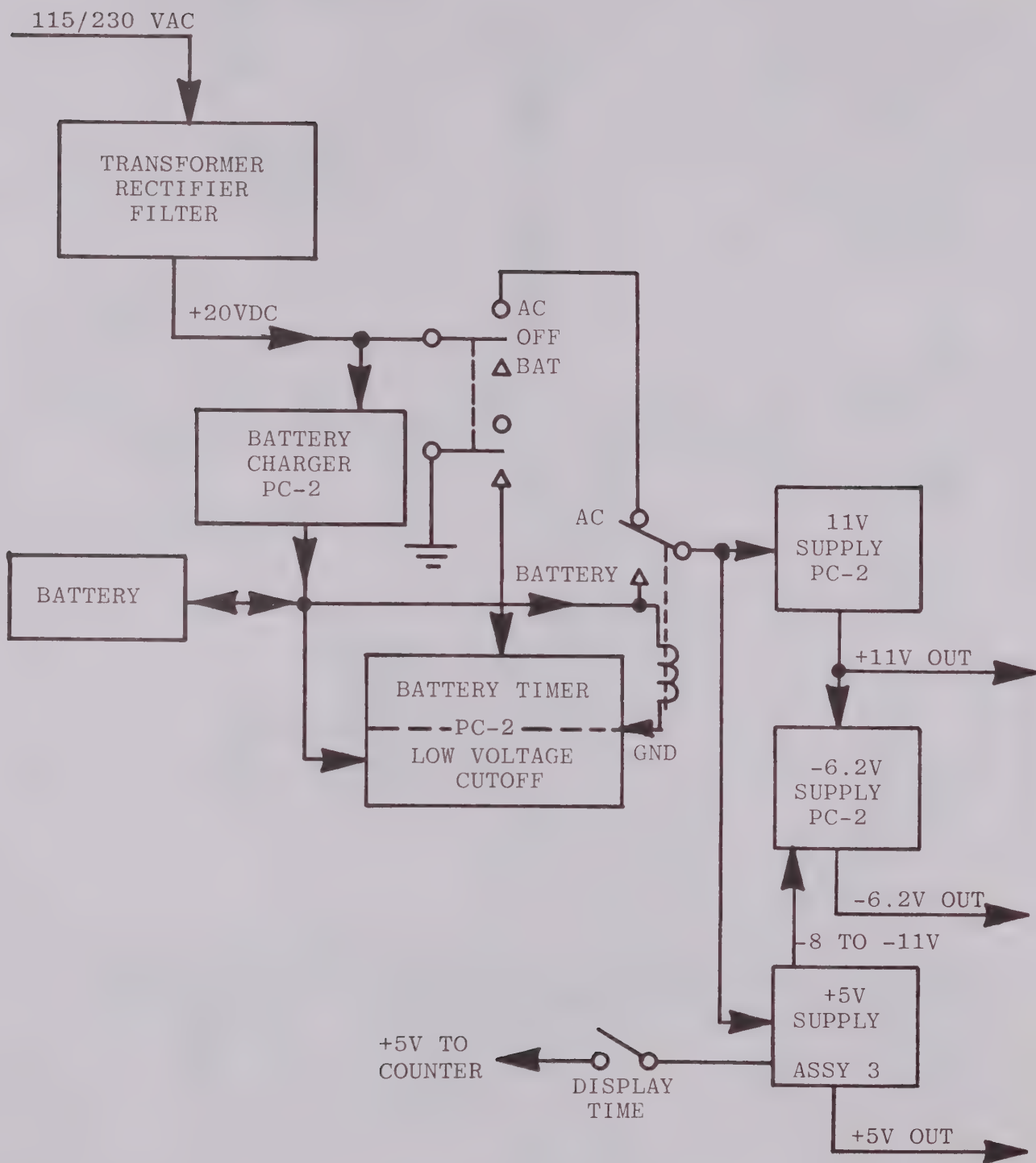


Fig. 4-7 Power Supply Block Diagram





TABLE OF CONTENTS  
NAV-401L

MAINTENANCE

| <u>SECTION 5</u> | <u>Performance Tests</u>                | <u>Page</u> |
|------------------|-----------------------------------------|-------------|
| 1                | Introduction                            | 5-1         |
| 2                | NAV Tones Test                          | 5-1         |
| 3                | DDM Centering Test                      | 5-3         |
| 4                | Distortion Tests                        | 5-4         |
| 5                | Percent Modulation of Tones Test        | 5-5         |
| 6                | Attenuator Output Level Tests           | 5-7         |
| 7                | RF Frequency Test                       | 5-8         |
| 8                | Bearing Error Tests                     | 5-9         |
| 9                | Bearing Check Test                      | 5-10        |
| 10               | Frequency Counter Tests                 | 5-11        |
| 11               | Power Meter Tests                       | 5-11        |
| 12               | Battery Voltage and Timer Tests         | 5-12        |
| 13               | Spectral Purity Test                    | 5-12        |
| 14               | Performance Test Data Sheet             | 5-15        |
| <br>             |                                         |             |
| <u>SECTION 6</u> | <u>Calibration Procedures</u>           |             |
| 1                | Introduction                            | 6-1         |
| 2                | Equipment Considerations                | 6-1         |
| 3                | Test Equipment Considerations           | 6-2         |
| 4                | Calibration Procedures                  | 6-2         |
| 4-2              | Front Panel                             | 6-2         |
| 4-3              | Power Supply Voltages                   | 6-3         |
| 4-4              | Tones                                   | 6-3         |
| 4-5              | Counter Clock Oscillator Frequency      | 6-7         |
| 4-6              | Generator Output Frequencies            | 6-8         |
| 4-7              | RF Output Level                         | 6-11        |
| 4-8              | Percent Modulation of Tones (Preferred) | 6-11        |
|                  | MKR Tones                               | 6-12        |
|                  | VOR Tones                               | 6-12        |
|                  | LOC Modulation and Centering            | 6-13        |
|                  | G/S Modulation and Centering            | 6-13        |
|                  | COMM Modulation                         | 6-14        |
| 4-9              | Percent Modulation of Tones (Alternate) | 6-14        |
|                  | MKR Tones                               | 6-15        |
|                  | VOR Tones                               | 6-16        |
|                  | LOC Modulation and Centering            | 6-17        |
|                  | G/S Modulation and Centering            | 6-17        |
|                  | COMM Modulation                         | 6-17        |
| 4-10             | Bearing Check Circuit                   | 6-18        |
| 4-11             | COMM Power Circuit                      | 6-19        |
| 4-12             | Battery Charger                         | 6-20        |
|                  | Calibration Data Sheet                  | 6-21        |
| 5                | Troubleshooting                         | 6-23        |

| <u>SECTION 7</u> <u>I.C. Guide</u>                 | <u>Page</u> |
|----------------------------------------------------|-------------|
| 7-1    Introduction                                | 7-1         |
| 7-3    List of Symbols                             | 7-1         |
| 7-5    Types of Logic Gates                        | 7-1         |
| 7-6    Buffer Symbol and Truth Table               | 7-1         |
| 7-7    Inverter Symbol and Truth Table             | 7-1         |
| 7-8    OR Symbol and Truth Table                   | 7-2         |
| 7-9    NOR Symbol and Truth Table                  | 7-2         |
| 7-10    XOR Symbol and Truth Table                 | 7-2         |
| 7-11    AND Symbol and Truth Table                 | 7-3         |
| 7-12    NAND Symbol and Truth Table                | 7-3         |
| 7-13    Data Selector                              | 7-3         |
| Integrated Circuit Guide Pin Outs and Truth Tables |             |
| CA3130 Op Amp                                      | 7-5         |
| CD4011AE COS/MOS Wuad 2 Input NAND                 | 7-5         |
| CD4040AE Ripple Binary Counter/Divider             | 7-5         |
| DD-700/DM8880 Decoder Driver                       | 7-5         |
| MC1027 AC-Coupled J-K Flip Flop                    | 7-5         |
| MC1666L Dual Clocked R-S Flip Flop                 | 7-5         |
| MC1692L Quad Line Receiver                         | 7-6         |
| MC1709CG/LM709H Op Amp                             | 7-6         |
| MC12013 Two-Modulus Prescaler                      | 7-6         |
| SN72558/MC1458 OP Amp                              | 7-6         |
| SN72741 Op Amp                                     | 7-6         |
| 7400 2 Input NAND Gate                             | 7-6         |
| SN7420 Quad Input NAND                             | 7-6         |
| SN7430 8 Input Positive NAND Gate                  | 7-6         |
| 7473 Dual J-K Flip Flop                            | 7-7         |
| 7475 4-Bit Latch                                   | 7-7         |
| 7490 Decoder Counter                               | 7-7         |
| SN7492 Divide-by Twelve Counter                    | 7-7         |
| 74S112 Dual J-K Flip Flop                          | 7-7         |

LIST OF FIGURES AND TABLES  
NAV-401L

MAINTENANCE

| <u>SECTION 5</u> | Performance Test                           | <u>Page</u> |
|------------------|--------------------------------------------|-------------|
|                  | None                                       |             |
| <u>SECTION 6</u> | Calibration Procedures                     |             |
| Fig. 6-1         | Phase Lock Pulse Adjustment                | 6-5         |
| Fig. 6-2         | 9960 Hz Deviation Adjustment               | 6-6         |
| Table 6-1        | Printed Circuit Board Test Points          | 6-23        |
| Table 6-2        | Troubleshooting chart                      |             |
|                  | Power Supply                               | 6-25        |
|                  | 1020, 400, 1300 and 3000 Hz Tone Generator | 6-25        |
|                  | VOR BRG Generator 90 and 150 Hz Tones      | 6-26        |
|                  | 30 Hz REF and 30 Hz VAR Sine Output        | 6-27        |
|                  | 90 and 150 Hz Sine Output                  | 6-28        |
|                  | Tones to Mode Switch                       | 6-29        |
|                  | Tones Out                                  | 6-29        |
|                  | Counter Clock Oscillator Frequency         | 6-29        |
|                  | Generator Output Frequencies               | 6-30        |
|                  | Phase Lock Section                         | 6-31        |
|                  | RF Output Level                            | 6-32        |
|                  | Percent Modulation                         | 6-32        |
|                  | LOC and G/S Centering                      | 6-33        |
|                  | Bearing Check Circuit                      | 6-33        |
|                  | Power Meter                                | 6-34        |
|                  | Counter Operation                          | 6-35        |
|                  | Battery Charger                            | 6-36        |
|                  | Battery Timer                              | 6-36        |
| <u>SECTION 7</u> | I.C. Guide                                 |             |
|                  | None                                       |             |



PERFORMANCE TESTS  
NAV-401L SECTION 5

1 Introduction.

- 1-1 This section contains procedures necessary to determine overall performance of the NAV-401L. Each test should be done in sequence given. Refer to SECTION 6 (Calibration) for adjustment procedures governing any parameters which do not meet specifications. If a failure or operational problem is encountered, refer to SECTION 6 (Troubleshooting) for guidance in locating the problem.
- 1-2 To maintain accurate measurements throughout the procedures, the test set signal generator output should be accurately tuned. The Tune Control (6) should be fine tuned whenever frequency is changed by more than a few MHz in any band, or whenever a different frequency band is selected on the Frequency Mode Switch (1), or when the Attenuator (9) is changed in the output range from -30 to -7 dBm. Characters shown in parenthesis after 401L controls, connectors and indicators are referenced in SECTION 3.

2 NAV Tones Test.

- 2-1 Connect frequency Counter to NAV Tones Output Connector (A) on NAV-401L Rear Panel.

Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . MKR XTL.  
MASTER MOD Level Control (24) . . . . . CAL.  
Tone Select Switch (17) . . . . . 1020.

Frequency Counter should indicate from 1010 Hz to 1030 Hz.

- 2-2 Set NAV-401L controls as indicated below:

Tone Select Switch (17) . . . . . 400.

Frequency Counter should indicate from 396 to 404 Hz.

- 2-3 Set NAV-401L controls as indicated below:

Tone Select Switch (17) . . . . . 1300.

Frequency Counter should indicate from 1287 to 1313 Hz.

2-4 Set NAV-401L controls as indicated below:

Tone Select Switch (17). . . . . .3000.

Frequency Counter should indicate from 2970 to 3030 Hz.

2-5 Set NAV-401L controls as indicated below:

Tone Select Switch (17). . . . . .CTR IN.  
Frequency MODE Switch (1). . . . . .VOR XTL.  
9960 Hz REF Level Control (23) . . . . .full ccw.  
30 Hz VAR Level Control (22) . . . . .full cw.

Frequency Counter should indicate 30 Hz.

2-6 Set NAV-401L controls as indicated below:

9960 Hz REF Level Control (23) . . . . .full cw.  
30 Hz VAR Level Control (22) . . . . .full ccw.

Frequency Counter should indicate 9960 Hz ( $\pm 100$  Hz). 9960 Hz is frequency modulated. This may cause an erroneous reading in some counters.

2-7 Disconnect Frequency Counter and connect Oscilloscope to NAV Tones Demodulated Output Connector (A) on NAV-401L Rear Panel.

Adjust Oscilloscope Scope Trigger and Position controls to vertically center the display. Position the sweep trigger point at left edge of horizontal centerline (ref. Fig. 6-2A)

Set Oscilloscope Controls as indicated below:

Vertical . . . . .200 mv/div. -  
Uncal.  
Horizontal . . . . .Delay Time Base:  
10  $\mu$ s/div.  
Trigger. . . . .Positive slope.

Check that deviation of expanded oscilloscope display (see Fig. 6-2B) corresponds to  $\Delta t = 48.5 \mu$ s ( $\pm 2.4 \mu$ s).

2-8 Disconnect Oscilloscope and connect Frequency Counter to NAV Tones Demodulated Output Connector (A) on NAV-401L Rear Panel.

2-8 (Cont.)

Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . LOC XTL.  
 G/S DDM Control (14). . . . . 0.  
 LOC DDM Control (21). . . . . 90 Hz.

Frequency Counter should indicate 90 Hz.

2-9 Set NAV-401L controls as indicated below:

LOC DDM Control (21) . . . . . 150 Hz.

Frequency Counter should indicate 150 Hz.

2-10 Disconnect Frequency Counter and connect an Oscilloscope to NAV Tones Demodulated Output Connector (A) on NAV-401L Rear Panel.

Set NAV-401L controls as indicated below:

LOC DDM Control (21) . . . . . 0.  
 VOR Bearing Select Switches (27) . . . . . 004.0.

Depress 90/150 Hz Variable Phase ( $\phi$ ) Switch (13) and note that relative amplitude of waveform peaks changes when the switch is depressed.

### 3 DDM Centering Tests.

3-1 Connect Digital Voltmeter (DVM) to Signal Generator Demodulated Output Connector (B) on NAV-401L Rear Panel.

Set NAV-401L controls as indicated below:

Tone Select Switch (17) . . . . . CTR IN.  
 LOC DDM Control (21). . . . . 0.  
 Frequency MODE Switch (1) . . . . . LOC XTL.  
 G/S DDM Control (14) . . . . . 150 Hz.  
 MASTER MOD Level Control (24) . . . . . CAL.

Note DVM indication.

3-2 Set NAV-401L controls as indicated below:

G/S DDM Control (14) . . . . . 90 Hz.

## 3-2 (Cont.)

DVM indication should be within  $\pm 2$  mV of indication noted in paragraph 3-1. Note DVM indication.

## 3-3 Set NAV-401L controls as indicated below:

G/S DDM Control (14) . . . . . 0.  
Frequency MODE Switch (1) . . . . . G/S XTL.  
LOC DDM Control (21) . . . . . 150 Hz.

Note DVM indication.

## 3-4 Set NAV-401L controls as indicated below:

LOC DDM Control (21) . . . . . 90 Hz.

DVM indication should be within  $\pm 2$  mVac of indication noted in paragraph 3-3.

4 Distortion Tests.

## 4-1 Disconnect DVM from NAV-401L.

Connect Low Pass Filter input (as shown in Fig. 1-1; or IFR P/N 1-00-166) to NAV Tones Demodulated Output Connector (A) on NAV-401L Rear Panel.

Connect Audio Distortion Meter to the output of Low Pass Filter.

Set NAV-401L controls as indicated below:

MASTER MOD Level Control (24) . . . . . CAL.  
Frequency MODE Switch (1) . . . . . MKR XTL.  
Tone Select Switch (17) . . . . . 1020.

Distortion Meter should indicate less than 1% harmonic distortion.

## 4-2 Set Tone Select Switch (17) to 400, 1300, and 3000 positions and verify that in each case, the meter indicates less than 1% harmonic distortion.

#### 4-3 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . VOR XTL.  
 9960 Hz REF Level Control (23). . . . . full ccw.  
 30 Hz VAR Level Control (22). . . . . full cw.  
 Tone Select Switch (17) . . . . . CTR IN.

Distortion Meter should indicate less than 0.65% harmonic distortion.

#### 4-4 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . LOC XTL.  
 G/S DDM Control (14). . . . . 0.  
 LOC DDM Control (21). . . . . 90.

Distortion Meter should indicate less than 0.65% harmonic distortion.

#### 4-5 Set NAV-401L controls as indicated below:

LOC DDM Control (21) . . . . . 150.

Distortion Meter should indicate less than 0.65% harmonic distortion.

### 5 Percent Modulation of Tones Tests.

#### 5-1 Set NAV-401L controls as indicated below:

MASTER MOD Level Control (24) . . . . . CAL.  
 Frequency MODE Switch (1) . . . . . MKR XTL.  
 Monitor Meter Function Switch (30). . . . . 100%.  
 Tone Select Switch (17) . . . . . 1020.

Connect Modulation Meter to RF Output Connector (10) on the Front Panel of the NAV-401L.

Modulation Meter should indicate 95% ( $\pm 5\%$ ). Check that NAV-401L MONITOR Meter (29) indicates approximately 95% modulation.

#### 5-2 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . VOR XTL.  
 30 Hz VAR Level Control (22). . . . . full ccw.  
 9960 Hz REF Level Control (23). . . . . full ccw.

## 5-2 (Cont.)

Modulation Meter should indicate 30% ( $\pm 2\%$ ). Check that NAV-401L MONITOR Meter (29) indicates approximately 30% modulation.

## 5-3 Set NAV-401L controls as indicated below:

Tone Select Switch (17) . . . . . MOD IN.  
30 Hz VAR Level Control (22). . . . . full cw.

Modulation Meter should indicate 30% ( $\pm 2\%$ ).

## 5-4 Set NAV-401L controls as indicated below:

30 Hz VAR Level Control (22) . . . . . full ccw.  
9960 Hz REF Level Control (23) . . . . . full cw.

Modulation Meter should indicate 30% ( $\pm 2\%$ ).

## 5-5 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . LOC XTL.  
LOC DDM Control (21). . . . . 0.  
G/S DDM Control (14). . . . . 90.  
Monitor Meter Function Switch (30). . . . . 30%.

Modulation Meter should indicate 20% ( $\pm 2\%$ ). Check that NAV-401L MONITOR Meter (29) indicates approximately 20% modulation.

## 5-6 Set NAV-401L controls as indicated below:

G/S DDM Control (14) . . . . . 150.

Modulation Meter should indicate 20% ( $\pm 2\%$ ).

## 5-7 Set NAV-401L controls as indicated below:

LOC DDM Control (21) . . . . . 90.  
Tone Select Switch (17). . . . . 1020.

Modulation Meter should indicate 30% ( $\pm 2\%$ ).

5-8 Set NAV-401L controls as indicated below:

G/S DDM Control (14). . . . . .0.  
 Monitor Meter Function Switch (30). . . . .100%.  
 Frequency MODE Switch (1) . . . . .G/S XTL

Modulation Meter should indicate 40% ( $\pm 2\%$ ). Check that NAV-401L Monitor Meter (29) indicates approximately 40% modulation.

5-9 Set NAV-401L controls as indicated below:

LOC DDM Control (21). . . . .150.

Modulation Meter should indicate 40% ( $\pm 2\%$ ).

5-10 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . .COMM XTL.

Modulation Meter should indicate 30% ( $\pm 2\%$ )

## 6 Attenuator Output Level Tests.

6-1 Set NAV-401L controls as indicated below:

MASTER MOD Level Control (24) . . . . .full ccw, out  
 of detent.  
 Output Attenuator (9) . . . . .-30.0 dBm.

Connect Power Meter to RF Output Connector (10).

Note output power level at each of the 5 crystal controlled frequencies as selected by the Frequency MODE Switch (1). Power Meter should indicate -30 dBm ( $\pm 2$  dBm) at each switch setting.

6-2 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . .COMM VAR.  
 Variable Frequency Controls (5) . . . . .144.0 MHz (as  
 displayed on  
 Counter {31}).

Power Meter should indicate -30 dBm ( $\pm 2$  dBm).

### 6-3 Set NAV-401L controls as indicated below:

|                            |          |
|----------------------------|----------|
| Frequency MODE Switch (1). | VOR XTL. |
| Output Attenuator (9).     | -25 dBm. |
|                            | -20 dBm. |
|                            | -15 dBm. |

Power Meter indication should agree with each Attenuator setting to within  $\pm 0.5$  dBm.

### 6-4 Set NAV-401L controls as indicated below:

|                                  |           |
|----------------------------------|-----------|
| Output Attenuator (9).           | -50 dBm.  |
| AVG/PEAK LOC XMTR ON Switch (12) | PEAK LOC. |
| Frequency MODE Switch (1).       | G/S XTL.  |

Power Meter should indicate from -15 to -20 dBm.

### 6-5 Set NAV-401L controls as indicated below:

|                                    |     |
|------------------------------------|-----|
| Monitor Meter Function Switch (30) | RF. |
|------------------------------------|-----|

Tune transmitter output. Check that MONITOR Meter (29) needle is centered when transmitter is tuned.

## 7 RF Frequency Tests.

### 7-1 Set NAV-401L controls as indicated below:

|                                      |                         |
|--------------------------------------|-------------------------|
| Fine Variable Frequency Control (5). | full ccw, detent.       |
| MASTER MOD Level Control (24).       | full ccw, not detented. |
| Frequency MODE Switch (1).           | VOR VAR.                |

Connect External Frequency Counter to NAV-401L RF Output Connector (10).

Adjust Coarse Variable Frequency Control for a phase-locked output frequency indication on NAV-401L of 110.000 MHz. External Frequency Counter should indicate 110.000 MHz ( $\pm 2.2$  kHz).

### 7-2 Set NAV-401L controls as indicated below:

|                            |          |
|----------------------------|----------|
| Counter Mode Switch (3).   | GEN.     |
| Frequency MODE Switch (1). | MKR XTL. |

External Counter should display Marker Crystal frequency,  $\pm 3$  kHz.

7-3 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1). . . . . VOR XTL.

External Counter should display VOR Crystal frequency,  $\pm 5$  kHz.

7-4 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1). . . . . LOC XTL.

External Counter should display Localizer Crystal frequency,  
 $\pm 5$  kHz.

7-5 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1). . . . . G/S XTL.

External Counter should display Glide Slope Crystal frequency,  
 $\pm 16$  kHz.

7-6 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1). . . . . COMM XTL.

External Counter should display COMM Crystal frequency,  
 $\pm 6$  kHz.

7-7 Set NAV-401L controls as indicated below:

Output Attenuator (9). . . . . -50 dBm.

Frequency MODE Switch (1). . . . . G/S XTL.

AVG/PEAK LOC XMTR ON Switch (12) . . . . . PEAK LOC.

External Counter should display LOC Transmitter crystal  
frequency,  $\pm 5$  kHz.

## 8 Bearing Error Tests. (using IFR CS-360 or CS-360D)

8-1 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1). . . . . VOR XTL.

MASTER MOD Level Control (24). . . . . CAL.

Tone Select Switch (17). . . . . CTR IN.

9960 Hz REF Level Control (23) . . . . . full cw.

30 Hz VAR Level Control (22) . . . . . full cw.

Set Controls on the CS-360(D) for RF input and  $90^0$  bearings.

Connect NAV-401L RF Output Connector (10) to CS-360(D) RF  
Input Connector.

Set RF input level to CS-360(D) with NAV-401L Attenuator  
Control (9).

## 8-1 (Cont.)

Set NAV-401L controls as indicated below:

VOR Bearing TO/FROM Switch (28) . . . . . TO.  
VOR Bearing Select Switch (27). . . . . 090.0.

CS-360(D) should indicate a bearing error of less than  $\pm 0.1^\circ$ .

## 8-2 Set NAV-401L controls as indicated below:

VOR Bearing TO/FROM Switch (28) . . . . . FROM.

CS-360(D) should indicate a bearing error of less than  $\pm 0.1^\circ$ .

## 8-3 Set NAV-401L controls as indicated below:

VOR Bearing Select Switches (27). . . . . 000.0.

Set CS-360(D) for a  $0^\circ$  bearing. CS-360(D) should indicate a bearing error of less than  $\pm 0.1^\circ$ .

## 8-4 Set NAV-401L controls as indicated below:

VOR Bearing TO/FROM Switch (28) . . . . . TO.

CS-360(D) should indicate a bearing error of less than  $\pm 0.1^\circ$ .

## 8-5 Disconnect the CS-360(D).

Select each digit of each decade on the VOR Bearing Select Switches (27), one digit at a time. Note that Digital Display (31) indicates the bearing selected on VOR Bearing Select Switches (27). Any Select Switch setting greater than  $360^\circ$  is invalid and the display should continue to indicate  $360.0^\circ$ .

9 Bearing Check Test.

## 8-1 Set NAV-401L controls as indicated below:

VOR Bearing TO/FROM Switch (28) . . . . . FROM.  
VOR Bearing Select Switches (27). . . . . 090.0.  
Monitor Meter Function Switch (30). . . . . BRG.  
Counter Mode Switch (3) . . . . . BRG.

## 9-1 (Cont.)

The Monitor Meter needle should deflect to mid-scale.

10 Frequency Counter Tests.

## 10-1 Set NAV-401L controls as indicated below:

Tone Select Switch (17) . . . . . CTR IN.  
Counter Mode Switch (3) . . . . . Hz.

Connect Signal Generator to MOD IN/CTR IN Connector (18).

Adjust Signal Generator Output of 0 dBm.

Vary Signal Generator Output Frequency from 1 MHz to 10 MHz. NAV-401L Digital Display (31) should display Signal Generator Frequency to within  $\pm 0.001\%$ .

## 10-2 Set NAV-401L controls as indicated below:

Counter Mode Switch (3) . . . . . MHz.

Vary Signal Generator Output Frequency from 10 MHz to 300 MHz. NAV-401L Digital Display (31) should display Signal Generator Frequency to within  $\pm 0.001\%$ .

11 Power Meter Tests.

## 11-1 Set NAV-401L controls as indicated below:

Monitor Meter Function Switch (30) . . . . . 100W.

Apply 30 to 50 Watts of unmodulated RF power through an accurate thru-line Power Meter to NAV-401L COMM Transmitter Input Connector (11).

The difference between the Monitor Meter indication and the Power Meter indication should be less than ( $\pm 3\%$  of full meter scale) + ( $\pm 5\%$  of Monitor Meter reading).

## 11-2 Apply 4 to 8 Watts of unmodulated RF power through an accurate thru-line Power Meter to NAV-401L COMM Transmitter Input Connector (11).

Set NAV-401L controls as indicated below:

Monitor Meter Function Switch (30) . . . . . 10W.

## 11-2 (Cont.)

The difference between the Monitor Meter indication and the Power Meter indication should be less than ( $\pm 3\%$  of full meter scale) + ( $\pm 5\%$  of Monitor Meter reading).

12 Battery Voltage and Timer Tests.

## 12-1 Set NAV-401L controls as indicated below:

Monitor Meter Function Switch (30) . . . . . BAT.

Monitor Meter (29) should indicate battery voltage on 0-30% scale. For a fully charged battery, the Monitor Meter should indicate 15 V. Voltage readings below 12 V indicate a discharged battery.

## 12-2 Set NAV-401L controls as indicated below:

AC/Battery Power Switch (25) . . . . . BAT.

Start Stopwatch to check that battery timer turns NAV-401L OFF after 6 to 10 minutes.

13 Spectral Purity Test.

## 13-1 Spectral Purity Test is an optional procedure that is to be performed if repairs or internal adjustments, other than oscillator frequency adjustments, are made on the Oscillator, Buffer Amplifier, or Transmitter.

Set NAV-401L controls as indicated below:

MASTER MOD Level Control (24) . . . . .full ccw,  
not detented.

Output Attenuator Control (9) . . . . .-30 dBm.

Connect Spectrum Analyzer to RF Output Connector (10).

Set Spectrum Analyzer controls for a 10 kHz/div. frequency span, and check that harmonics over entire frequency range of each band of the test set are greater than 20 dB below the carrier level.

- 13-2 Set Spectrum Analyzer controls for a 300 Hz resolution bandwidth. Use 10 Hz filter.

Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . VOR XTL.

Check that close-in noise is greater than 68 dB below carrier level, beyond  $\pm 20$  kHz of carrier frequency.

Check that broadband noise, beyond  $\pm 50$  kHz of carrier frequency, is greater than 70 dB below carrier level.

- 13-3 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . G/S XTL.

Check that close-in noise is greater than 62 dB below carrier level, beyond  $\pm 20$  kHz of the center frequency.

Check that broadband noise, beyond  $\pm 50$  kHz of carrier frequency, is greater than 70 dB below carrier level.

- 13-4 Set NAV-401L controls as indicated below:

Frequency MODE Switch (1) . . . . . VOR VAR.

Fine Variable Frequency Control (5) . . . . . full ccw,  
detent.

Coarse Variable Frequency Control (5) . . . . . 110.000 MHz.

Check that 25 kHz phase lock loop reference noise, or 10 to 30 kHz switching regulator noise is greater than 55 dB below carrier level.



---

NAV-401L PERFORMANCE TESTS

---

## 14 PERFORMANCE TEST DATA SHEET

## 2 NAV TONES

|      |                                 |              |       |                         |
|------|---------------------------------|--------------|-------|-------------------------|
| 2-1  | 1020 Hz MKR                     | 1010 Hz      | _____ | 1030 Hz                 |
| 2-2  | 400 Hz MKR                      | 396 Hz       | _____ | 404 Hz                  |
| 2-3  | 1300 Hz MKR                     | 1287 Hz      | _____ | 1313 Hz                 |
| 2-4  | 3000 Hz MKR                     | 2970 Hz      | _____ | 3030 Hz                 |
| 2-5  | 30 Hz VOR VAR                   |              | _____ | 30 Hz ( $\pm 0.02\%$ )  |
| 2-6  | 9960 Hz VOR                     |              | _____ | 9960 Hz ( $\pm 100$ Hz) |
| 2-7  | VOR FM Deviation ( $\Delta t$ ) | 46.1 $\mu$ s | _____ | 50.9 $\mu$ s            |
| 2-8  | 90 Hz LOC-G/S                   |              | _____ | 90 Hz ( $\pm 0.02\%$ )  |
| 2-9  | 150 Hz LOC-G/S                  |              | _____ | 150 Hz ( $\pm 0.02\%$ ) |
| 2-10 | 90/150 Hz Phase Shift           |              | _____ | ✓                       |

## 3 DDM CENTERING

|     |                              |       |                       |
|-----|------------------------------|-------|-----------------------|
| 3-1 | 150 Hz LOC Demod             | _____ | $\pm 2$ mVac of above |
| 3-2 | 90 Hz LOC Demod (Ref to 3-1) | _____ |                       |
| 3-3 | 150 Hz G/S Demod             | _____ | $\pm 2$ mVac of above |
| 3-4 | 90 Hz G/S Demod (Ref to 3-3) | _____ |                       |

## 4 DISTORTION (Harmonic)

|     |           |       |        |
|-----|-----------|-------|--------|
| 4-1 | 1020 Hz   | _____ | <1%    |
| 4-2 | 400 Hz    | _____ | <1%    |
|     | 1300 Hz   | _____ | <1%    |
|     | 3000 Hz   | _____ | <1%    |
| 4-3 | 30 Hz VAR | _____ | <0.65% |
| 4-4 | 90 Hz     | _____ | <0.65% |
| 4-5 | 150 Hz    | _____ | <0.65% |

## 5 PERCENT MODULATION OF TONES

|      |                 |     |       |      |
|------|-----------------|-----|-------|------|
| 5-1  | 1020 Hz MKR XTL | 90% | _____ | 100% |
| 5-2  | 1020 Hz VAR VOR | 28% | _____ | 32%  |
| 5-3  | 30 Hz VAR VOR   | 28% | _____ | 32%  |
| 5-4  | 9960 Hz VOR     | 28% | _____ | 32%  |
| 5-5  | 90 Hz LOC       | 18% | _____ | 22%  |
| 5-6  | 150 Hz LOC      | 18% | _____ | 22%  |
| 5-7  | 1020 Hz LOC     | 28% | _____ | 32%  |
| 5-8  | 90 Hz G/S       | 38% | _____ | 42%  |
| 5-9  | 150 Hz G/S      | 38% | _____ | 42%  |
| 5-10 | 1020 Hz COMM    | 28% | _____ | 32%  |

## 14 PERFORMANCE TEST DATA SHEET

## 6 ATTENUATOR OUTPUT LEVEL

|     |                                        |         |       |            |
|-----|----------------------------------------|---------|-------|------------|
| 6-1 | MKR XTL                                | -28 dBm | _____ | -32 dBm    |
|     | VOR XTL                                | -28 dBm | _____ | -32 dBm    |
|     | LOC XTL                                | -28 dBm | _____ | -32 dBm    |
|     | G/S XTL                                | -28 dBm | _____ | -32 dBm    |
|     | COMM XTL                               | -28 dBm | _____ | -32 dBm    |
| 6-2 | COMM VAR (144.0 MHz)                   | -28 dBm | _____ | -32 dBm    |
| 6-3 | VOR XTL -25 dBm (Ref Atten Corr Chart) |         | _____ | (±0.5 dBm) |
|     | -20 dBm (Ref Atten Corr Chart)         |         | _____ | (±0.5 dBm) |
|     | -15 dBm (Ref Atten Corr Chart)         |         | _____ | (±0.5 dBm) |
| 6-4 | LOC Transmitter                        | -15 dBm | _____ | 120 dBm    |
| 6-5 | Monitor Meter Centering                |         | _____ | ✓          |

## 7 RF FREQUENCY

|     |                       |       |          |
|-----|-----------------------|-------|----------|
| 7-1 | VOR VAR (110.000 MHz) | _____ | ±2.2 kHz |
| 7-2 | MKR XTL               | _____ | ±3 kHz   |
| 7-3 | VOR XTL               | _____ | ±5 kHz   |
| 7-4 | LOC XTL               | _____ | ±5 kHz   |
| 7-5 | G/S XTL               | _____ | ±16 kHz  |
| 7-6 | COMM XTL              | _____ | ±6 kHz   |
| 7-7 | LOC XMTR XTAL         | _____ | ±5 kHz   |

## 8 BEARING ERROR (With IFR CS-360D)

|     |          |       |        |
|-----|----------|-------|--------|
| 8-1 | 90° TO   | _____ | <±0.1° |
| 8-2 | 90° FROM | _____ | <±0.1° |
| 8-3 | 0° FROM  | _____ | <±0.1° |
| 8-4 | 0° TO    | _____ | <±0.1° |

## 9 BEARING CHECK

|     |                                |       |   |
|-----|--------------------------------|-------|---|
| 9-1 | 90° FROM, Mid-scale deflection | _____ | ✓ |
|-----|--------------------------------|-------|---|

## 10 FREQUENCY COUNTER

|      |                            |       |          |
|------|----------------------------|-------|----------|
| 10-1 | Max Dev from Gen Frequency | _____ | <±0.001% |
| 10-2 | Max Dev from Gen Frequency | _____ | <±0.001% |

## 11 POWER METER

|      |               |       |                                                    |
|------|---------------|-------|----------------------------------------------------|
| 11-1 | 30-50 W Input | _____ | (±3% of full meter scale) + (±5% of meter reading) |
| 11-2 | 4-8 W Input   | _____ | (±3% of full meter scale) + (±5% of meter reading) |

---

NAV-401L PERFORMANCE TESTS

---

14 PERFORMANCE TEST DATA SHEET

12 BATTERY VOLTAGE AND TIMER

|      |                 |       |       |        |
|------|-----------------|-------|-------|--------|
| 12-1 | Battery Voltage | +12 V | _____ | +15 V  |
| 12-2 | Timer Operation | 6 min | _____ | 10 min |

13 SPECTRAL PURITY

|      |                                  |       |         |
|------|----------------------------------|-------|---------|
| 13-1 | Harmonics                        | _____ | >20 dBc |
| 13-2 | VOR XTL, Close-in Noise          | _____ | >68 dBc |
|      | VOR XTL, Broadband Noise         | _____ | >70 dBc |
| 13-3 | G/S XTL, Close-in Noise          | _____ | >62 dBc |
|      | G/S XTL, Broadband Noise         | _____ | >70 dBc |
| 13-3 | PLL or Switching Regulator Noise | _____ | >55 dBc |



## CALIBRATION PROCEDURES

### NAV-401L SECTION 6

EFFECTIVE S/N 1636 AND AFTER (unless otherwise specified)

#### 1 Introduction

- 1-1 Follow calibration procedures in the order as sequenced. Use individual procedures to calibrate individual systems only if effecting circuitry has been calibrated or has been verified by the appropriate Performance Evaluation Procedures in Section 5.
- 1-2 Unless otherwise specified, verify the results of each procedure and take corrective action whenever a calibration requirement is not met. "Corrective Action" can mean either troubleshooting the unit to determine component failure and replacing that component or making a mechanical or electrical repair to restore normal operation.
- 1-3 Results of the calibration procedures may be recorded in the Calibration Data Sheet at the end of the Calibration Procedures. The recorded results can be used for comparison in future calibrations, troubleshooting and for references after repair and inspection.
- 1-4 For locations of calibration test points and components, refer to Sections 8 and 10.

#### 2 Equipment Considerations

- 2-1 For best results, calibrate the set using environmental conditions as close as possible to those of normal operating location.
- 2-2 Calibration procedures are performed with equipment covers removed and standard ac power applied, except as noted.

#### WARNING

- \* Turn power switch "OFF" and remove external power connections prior to removing equipment covers.
- \* Do not interrupt internal or external grounding conductors.
- \* Remove power before removing or installing any component.
- \* Contact with many points may result in personal injury. Only qualified personnel should attempt calibration, maintenance or repair.

### 3 Test Equipment Considerations

- 3-1 Each calibration procedure specifies required test equipment.
- 3-2 When using PC Board Extenders, support PC board with a brace of nonconductive material to assure proper positioning and electrical contact.

### 4 Calibration Procedures

- 4-1 To maintain accurate measurements throughout the procedures, the test set signal generator output should be accurately tuned. The Tune Control (7) on the front panel should be fine tuned whenever the frequency is changed by more than a few megahertz in any band, whenever a different frequency band is selected on the Frequency Mode Switch (1), or when the attenuator is changed in the output range of -30 dBm to -7 dBm.

#### 4-2 FRONT PANEL

DESCRIPTION: The following procedures are not intended to be daily tests, but to be used in a regularly scheduled preventive maintenance program.

#### 4-3 POWER SUPPLY VOLTAGES

DESCRIPTION: This procedure checks the output voltage of the 11 volt and 5 volt power supplies.

TEST EQUIPMENT: Digital Voltmeter

PROCEDURES:

1. Connect digital voltmeter to terminal 3 of PC-1.
2. Adjust 11 volt regulator adjustment (R210) on PC-2 to obtain a voltmeter indication of +11.00 V ( $\pm 0.10$  V).
3. Connect voltmeter to terminal F of PC-1.
4. Adjust 5 volt regulator adjustment (R1158) on 5 Volt Regulator Board to obtain a voltmeter indication of +5.00 V (+4.90 to +5.00 V).
5. Connect voltmeter to terminal 2 of PC-1. Voltmeter should indicate -6.20 V ( $\pm 0.20$  V).

---

#### 4-4 TONES

DESCRIPTION: This procedure is used to adjust frequency and harmonic distortion.

TEST EQUIPMENT: Harmonic Distortion Meter  
Frequency Counter  
Oscilloscope (dual trace)

PROCEDURE: 1020 Hz, 400 Hz, 1300 Hz, 3000 Hz.

1. Connect harmonic distortion meter to MKR Tone Oscillator Sine Output (TP201) on PC-2. See Regulator-Timer Board layout for test point location (Fig. 8-4).
2. Set Tone Select Switch (17) to 1020.
3. Adjust tone oscillator amplitude adjustment (R253) and tone oscillator centering adjustment (R273) to obtain minimum distortion (1% maximum).
4. Connect external frequency counter to MKR Tone Oscillator Sine Output (TP201) on PC-2.

#### 4-4 TONES (cont'd)

5. Set Tone Select Switch (17) to 1020 and adjust R262 on PC-2 to obtain a counter indication of 1020 Hz ( $\pm 5$  Hz). Repeat steps 1 thru 3.
6. Set Tone Select Switch (17) to 400 and adjust R260 on PC-2 to obtain a counter indication of 400 Hz ( $\pm 2$  Hz).
7. Set Tone Select Switch (17) to 1300 and adjust R266 on PC-2 to obtain a counter indication of 1300 Hz ( $\pm 5$  Hz).
8. Set Tone Select Switch (17) to 3000 and adjust R264 on PC-2 to obtain a counter indication of 3000 Hz ( $\pm 15$  Hz).
9. Disconnect external frequency counter and connect harmonic distortion meter to MKR Tone Oscillator Sine Output (TP201) on PC-2.
10. Set Tone Select Switch (17) to 400, 1300, and 3000 Hz positions and check that distortion for each tone is not more than 1%.

PROCEDURE: 30 Hz REF, 30 Hz VAR, 90 Hz, 150 Hz.

1. Connect frequency counter to 2160 KHz Oscillator Output (TP501) on PC-5. See VOR Bearing Logic Board layout for test point location (Fig. 8-10).
2. Counter should indicate frequency of 2160 KHz ( $\pm 432$  Hz). If frequency is not far off tolerance, crystal may be padded by placing small values of capacitance in parallel with the crystal to lower the frequency. The series capacitor may be increased in value to raise the frequency.

PROCEDURE: 30 Hz Sine, 9960 Hz FM Output.

1. Connect harmonic distortion meter to the 30 Hz VAR Sine Output (TP403) on PC-4. See 30 Hz Sine Board layout for test point location (Fig. 8-8).
2. Adjust amplitude trim pot (R489) and centering trim pot (R492) to obtain minimum distortion ( $< 0.5\%$ ).
3. Connect harmonic distortion meter to the 30 Hz REF Sine Output (TP401) on PC-4.
4. Adjust amplitude trim pot (R406) and centering trim pot (409) to obtain minimum distortion ( $< 0.5\%$ ).
5. Connect oscilloscope to the 9960 Hz FM Sine Output (TP402) on PC-4.

## 4-4 TONES (cont'd)

6. Adjust the 480 Hz deviation trim pot (R435) full ccw until no frequency modulation is evident on the oscilloscope display.
7. Connect harmonic distortion meter to the 9960 Hz FM Sine Output (TP402) on PC-4.
8. Adjust amplitude trim pot (R451) and centering trim pot (R4016) to obtain minimum distortion (<1.5%).
9. Connect channel 1 of a dual trace oscilloscope to the 30 Hz REF triangle waveform output, pin 6 of X401.
10. Use oscilloscope channel 2 to monitor phase lock pulse at collector (case) of Q406.
11. Adjust the 9960 Hz frequency adjustment (R437) to position phase lock pulse coincident with zero crossing of rising portion of 30 Hz REF triangle wave. See figure 6-1.
12. Connect frequency counter to the 9960 Hz FM Sine Output (TP402) on PC-4. Counter should indicate 9960 Hz ( $\pm 1$  Hz) ( $\pm 100$  Hz for sets without phase locked 9960 Hz).
13. Connect oscilloscope to TP402 and set controls as specified in figure 6-2(A).
14. Adjust scope trigger and position controls to vertically center the display and position the sweep trigger point at the left edge of the horizontal centerline as shown in figure 6-2(A).
15. Set oscilloscope controls as specified in figure 6-2(B).
16. Adjust the 480 Hz deviation pot (R435) for a  $\Delta t$  of 48.5  $\mu$ s ( $\pm 2.4 \mu$ s) using the delayed sweep function to expand the display as shown in figure 6-2(B).

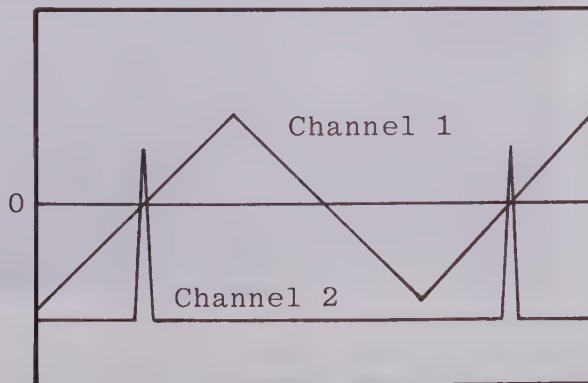
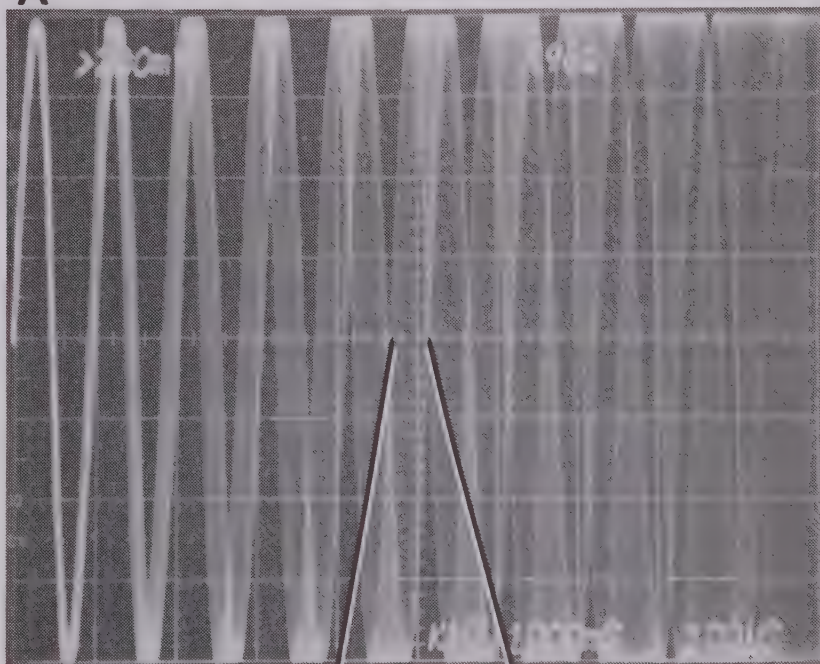


Figure 6-1. Phase Lock Pulse Adjustment

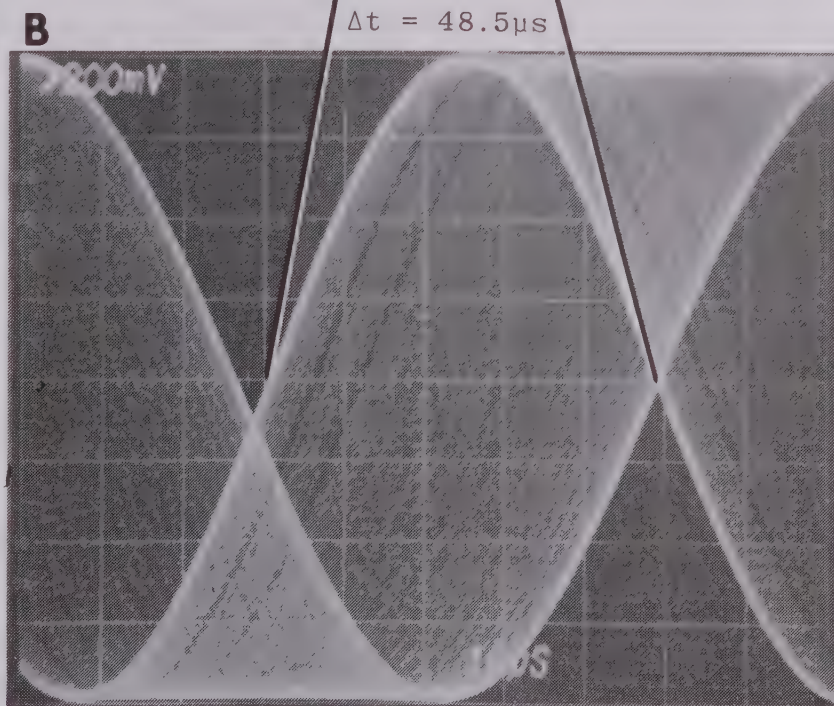
FM Deviation;  $\pm 480(\pm 24)\text{Hz}$ **A**

## SCOPE SETTINGS

Vertical:  
200mV/Div-UncalHorizontal:  
Main Time Base  
100µs/DivTrigger:  
Positive Slope

## NOTE

Accuracy of calibration depends on oscilloscope sweep timing accuracy.

**B**

## SCOPE SETTINGS

Vertical:  
200mV/Div-UncalHorizontal:  
Delay Time Base  
10µs/DivTrigger:  
Positive Slope

Fig. 6-2 9960 Hz Deviation Adjustment

#### 4-4 TONES (cont'd)

PROCEDURE: 90 Hz., 150 Hz

1. Connect harmonic distortion meter to the 90 Hz Sine Output (TP301) on PC-3. See Combination Sine Board Layout for test point location (Fig. 8-6)..
2. Adjust amplitude trim pot (R306) and centering trim pot (R312) to obtain minimum distortion (<0.5%).
3. Connect harmonic distortion meter to the 150 Hz Sine Output (TP302) on PC-3.
4. Adjust amplitude trim pot (R344) and centering trim pot (R347) to obtain minimum distortion (<0.5%).

---

#### 4-5 COUNTER CLOCK OSCILLATOR FREQUENCY

DESCRIPTION: Two methods of calibrating the counter oscillator frequency are given. Perform the procedure best suited for the available equipment.

TEST EQUIPMENT: Receiver for station WWV (NBS station)  
or  
Frequency Counter

PROCEDURE: WWV Zero Beat Calibration

1. Tune a receiver to NBS station WWV at 5, 10 or 15 MHz. Use frequency with best signal strength and most stable output.
2. Connect one end of a test wire to the 100 kHz Clock Output (TP107) on PC-1. See Bearing Check Board layout for test point location (Fig. 8-2).
3. Place free end of test wire near receiver antenna terminals so that signal is heard through receiver.
4. Adjust trimmer capacitor (C123) on PC-1 for zero beat between the 100 kHz output and WWV carrier signal.

PROCEDURE: Phase Lock Time Base Calibration

1. Set Frequency MODE Switch (1) to VOR VAR.
2. Adjust Fine Variable Frequency Control (inner dial) full ccw into the detent, phase lock, position.

#### 4-5 COUNTER CLOCK OSCILLATOR FREQUENCY (cont'd)

3. Adjust Coarse Variable Frequency Control (outer dial) to phase lock on any frequency except VOR XTL frequency.

##### NOTE

If the Variable Frequency Oscillator is set to the VOR XTL oscillator frequency, interaction between the two oscillators could result in calibration error.

4. Connect an external frequency counter to RF Output Connector (10).
5. Adjust Master Mod Control (24) full ccw, out of CAL position. Tune the Transmitter.
6. Adjust trimmer capacitor (C123) on PC-1 so that frequency indicated on frequency counter matches that indicated on Digital Display (31),  $\pm 0.0005\%$ .

---

#### 4-6 GENERATOR OUTPUT FREQUENCIES

**DESCRIPTION:** This procedure checks the output frequencies of the RF generator. Test set frequency counter time base must be calibrated before initiating this procedure. If procedure 4-5 has not been performed, it should be accomplished at this time or an external 400 MHz frequency counter should be connected to RF Output Connector (10).

**TEST EQUIPMENT:** Digital Voltmeter  
Frequency Counter (optional)

##### PROCEDURE:

1. Connect digital voltmeter to collector of Q703 or to FL711. See Oscillator Board Layout for location (Fig. 8-23).
2. Adjust R746 to obtain voltmeter indication of 10.5 V ( $\pm 0.1$  V.)
3. Set Counter Mode Switch (3) to GEN.
4. Set Frequency MODE Switch (1) to MKR XTL.

## 4-6 GENERATOR OUTPUT FREQUENCIES (cont'd)

5. Adjust L710 for most stable oscillator operation.  
Digital Display (31) should indicate 75.000 MHz ( $\pm 3$  kHz).
6. If frequency is too high, up to 5 pF may be added across crystal to lower frequency. If frequency is too low, crystal must be replaced.
7. Set Frequency MODE Switch (1) to VOR XTL.
8. Adjust L711 for most stable oscillator operation.  
Digital Display (31) should indicate 108.000 MHz ( $\pm 5$  kHz).
9. If frequency is too high, up to 5 pF may be added across crystal to lower frequency. If frequency is too low, crystal must be replaced.
10. Set Frequency MODE Switch (1) to LOC XTL.
11. Adjust L714 for most stable oscillator operation.  
Digital Display (31) should indicate 108.100 MHz ( $\pm 5$  kHz).
12. If frequency is too high, up to 5 pF may be added across crystal to lower frequency. If frequency is too low, crystal must be replaced.
13. Set Frequency MODE Switch (1) to G/S XTL.
14. Adjust L712 for most stable oscillator operation.  
Digital Display (31) should indicate 334.700 MHz ( $\pm 16$  kHz).

## NOTE

Since the signal generator triples the oscillator frequency for glide slope operation, the crystal for G/S XTL is 111.566 MHz.

15. Set Frequency MODE Switch (1) to COMM XTL.
16. Adjust L713 for most stable oscillator operation.  
Digital Display (31) should indicate 126.900 MHz ( $\pm 6$  kHz).
17. If frequency is too high, up to 5 pF may be added across crystal to lower frequency. If frequency is too low, crystal must be replaced.

## 4-6 GENERATOR OUTPUT FREQUENCIES (cont'd)

18. Set Frequency MODE Switch (1) to MKR VAR.
19. Adjust Variable Frequency Controls (5) full cw.
20. If necessary, adjust L703 for minimum Digital Display (31) indication of 78 MHz.

## NOTE

Adjustment of L703 affects all the VAR bands.  
If L703 is adjusted, it will be necessary to  
adjust all of the other bands.

21. Set Frequency Mode Switch (1) to VOR VAR.
22. If necessary adjust L704 for minimum Digital Display (31) indication of 120 MHz.
23. Set Frequency MODE Switch (1) to COMM VAR HI.
24. If necessary, adjust L706 for minimum Digital Display (31) indication of 158 MHz.
25. Set Frequency MODE Switch (1) to COMM VAR LO.
26. If necessary, adjust L705 for minimum Digital Display (31) indication of 136 MHz.
27. Adjust Variable Frequency Controls (5) full ccw but do not set fine adjustment control into detent.
28. Adjust R745 for maximum Digital Display (31) indication of lower limits on each band as noted below:

|                         |         |
|-------------------------|---------|
| COMM VAR LO Lower Limit | 117 MHz |
| COMM VAR HI Lower Limit | 134 MHz |
| LOC VAR Lower Limit     | 107 MHz |
| VOR VAR Lower Limit     | 107 MHz |
| MKR VAR Lower Limit     | 72 MHz  |
| G/S VAR Lower Limit     | 327 MHz |

29. Repeat steps 18 through 28 as required to insure that all bands are within desired ranges.

#### 4-7 RF OUTPUT LEVEL

DESCRIPTION: This procedure is used to check the RF Output Level and calibrate the Output Attenuator Control (9).

TEST EQUIPMENT: RF Power Meter

##### PROCEDURE:

1. Set Monitor Meter Function Switch (30) to RF.
2. Adjust Tune Control (7) until Tune Indicator (6) is no longer illuminated.
3. Press Fine Tune Switch (8) and adjust Tune Control (7) for minimum meter indication.
4. Adjust RF Level trim pot (R386) to center meter needle in white band in center of scale.
5. Repeat steps 2 and 3 for each position on the Frequency MODE Switch (1) to center meter for each band.
6. Set Frequency MODE Switch (1) to VOR XTL.
7. Adjust Master Mod Level Control (24) full ccw, out of detent position.
8. Connect RF Power Meter to RF Output Connector (10).
9. Adjust Output Attenuator Control (9) to -30 dBm.
10. Loosen the two attenuator knob set screws closest to dial.
11. Hold dial at -30 dBm setting and turn knob until power meter indicates -30 dBm.
12. Tighten set screws. Dial calibrations and actual RF level output should agree from -30 dBm to -120 dBm. Refer to Attenuator Correction Chart provided with test set for measured frequency response at time of calibration.

---

#### 4-8 PERCENT MODULATION OF TONES (PREFERRED)

DESCRIPTION: Two procedures are given for calibrating the percent modulation of tones. The first procedure is the most accurate and is the preferred method of calibration. The alternate procedure is less accurate, but does not require an accurate modulation meter.

#### 4-8 PERCENT MODULATION OF TONES (PERFERRED) (cont'd)

TEST EQUIPMENT: Modulation Meter (Preferred)  
Digital Voltmeter (Preferred)  
PC Board Extender

##### PROCEDURE: MKR Tones

1. Remove power from test set. Remove PC-4 and reinstall using PC Board Extender. Reapply power to test set.
2. Set Frequency MODE Switch (1) to MKR XTL and Tone Select switch (17) to 1020 Hz.
3. Connect external modulation meter to RF Output Connector (10).
4. Adjust Master Mod Level Control (24) to obtain external modulation meter indication of 100%.
5. Set Monitor Meter Function Switch (30) to 100%.
6. Adjust the 100% Modulation trim pot (R391) on PC-3 to obtain full scale Monitor Meter (29) indication of 100%.
7. Adjust Master Mod Level Control (24) to obtain external modulation meter indication of 30%.
8. Set Monitor Meter Function Switch (30) to 30%.
9. Adjust the 30% Modulation trim pot (R389) on PC-3 to obtain full scale Monitor Meter (29) indication of 30%.
10. Set Master Mod Level Control (24) to CAL.
11. Adjust MKR trim pot (R433) on PC-4 to obtain external modulation meter indication of 95%.

##### PROCEDURE: VOR Tones

1. Set Frequency MODE Switch (1) to VOR XTL and Master Mod Level Control (24) to CAL.
2. Adjust the 9960 Hz REF Level Control (23) full ccw and the 30 Hz VAR Level Control (22) full cw to 30% position.
3. Adjust the 30 Hz VAR trim pot (R431) on PC-4 to obtain external modulation meter indication of 30%.

## 4-8 PERCENT MODULATION OF TONES (PREFERRED) (cont'd)

4. Adjust the 30 Hz VAR Level Control (22) full ccw and the 9960 Hz REF Level Control (23) full cw to 30% position.
5. Adjust the 9960 Hz trim pot (R432) to obtain external modulation meter indication of 30%.
6. Adjust the 9960 Hz REF Level Control (23) full ccw.
7. Set Tone Select Switch (17) to 1020.
8. Adjust VOR Tone trim pot (R4087) to obtain external modulation meter indication of 30%.

## PROCEDURE: LOC Modulation and Centering

1. Delete the 90 Hz signal by setting LOC DDM Control (21) to 0 and G/S DDM Control (14) to 150.
2. Set Frequency MODE Switch (1) to LOC XTL.
3. Connect external modulation meter to RF Output Connector (10).
4. Adjust LOC trim pot (R454) to obtain external modulation meter indication of 20%.
5. Connect digital voltmeter to Signal Generator Demodulated Output Connector (B) on back panel and record ac voltage level.
6. Delete 150 Hz signal by setting G/S DDM Control (14) to 90.
7. Center LOC tones by adjusting LOC Centering Adjustment (19) to obtain voltmeter indication equal to value recorded in step 5 ( $\pm 0.001$  Vac).

## PROCEDURE: G/S Modulation and Centering

1. Delete the 90 Hz signal by setting G/S DDM Control (14) to 0 and LOC DDM Control (21) to 150.
2. Set Frequency MODE Switch (1) to G/S XTL.
3. Connect external modulation meter to RF Output Connector (10).
4. Adjust G/S Modulation trim pot (R482) to obtain external modulation meter indication of 40%.

## 4-8 PERCENT MODULATION OF TONES (PREFERRED) (cont'd)

5. Connect digital voltmeter to Signal Generator Demodulated Output Connector (B) and record ac voltage indicated.
6. Delete 150 Hz signal by setting LOC DDM Control to 90.
7. Adjust G/S Centering Adjustment (15) to obtain a voltmeter indication equal to that recorded in step 5 ( $\pm 0.001$  Vac).

## PROCEDURE: COMM Modulation

1. Set Frequency MODE Switch (1) to COMM XTL.
2. Set Tone Select Switch (17) to 1020.
3. Adjust COMM Modulation trim pot (R4014) to obtain external modulation meter indication of 30%.
4. Remove power from test set, reinstall PC-4 without PC Board Extender and reapply power.

---

4-9 PERCENT MODULATION OF TONES (ALTERNATE)

DESCRIPTION: This procedure for calibrating the percent modulation of tones is not as accurate as that given in 4-8, but may be used when an accurate modulation meter is not available.

TEST EQUIPMENT: Digital multimeter

## PROCEDURE: Equipment Setup

1. Disconnect P802 from rear of transmitter assembly. See figure 10-1-1.
2. Connect digital multimeter to Signal Generator Demodulated Output Connector (B) and apply power to the test set.
3. Set Frequency MODE Switch (1) to MKR XTL and record dc offset voltage indicated (approx. 260 mV). Define this voltage as MKR V1.
4. Set Frequency MODE Switch (1) to VOR XTL and record dc offset voltage indicated (approx. 260 mV). Define this voltage as VOR V1.
5. Set Frequency MODE Switch (1) to LOC XTL and record dc offset voltage indicated (approx. 260 mV). Define this voltage as LOC V1.

#### 4-9 PERCENT MODULATION OF TONES (ALTERNATE) (cont'd)

6. Set Frequency MODE Switch (1) to G/S XTL and record dc offset voltage indicated (approx. 300 mV). Define this voltage as G/S V1.
7. Set Frequency MODE Switch (1) to COMM XTL and record dc offset voltage indicated (approx. 260 mV). Define this voltage as COMM V1.
8. Remove power from test set and reconnect P802 to transmitter.

#### PROCEDURE: MKR Tones

1. Set Frequency MODE Switch (1) to MKR XTL and Tone Select Switch (17) to 1300).
2. Adjust Master Mod Level Control (24) to CAL and record dc voltage indicated (approx. 4 V). Define this voltage as MKR V2.
3. Calculate ac voltage for 100% modulation by substituting recorded values into the following equation:

$$\text{Vac for 100\% Modulation} = \frac{\text{MKR V2} - \text{MKR V1}}{1.414}$$

4. Adjust Master Mod Level Control (24) to obtain ac voltage indication equal to the value calculated in step 3.
5. Set Monitor Meter Function Switch (30) to 100%.
6. Adjust the 100% Modulation trim pot (R391) on PC-3 for full scale Monitor Meter (29) indication of 100%.
7. Multiply the value calculated in step 3 by 0.30 to obtain ac voltage required for 30% modulation.
8. Adjust Master Mod Level Control (24) to obtain ac voltage indication equal to the value calculated in step 7.
9. Set Monitor Meter Function Switch (30) to 30%.
10. Adjust the 30% Modulation trim pot (R389) on PC-3 for full scale Monitor Meter (29) indication of 30%.
11. Set Master Mod Level Control (24) to CAL.

#### 4-9 PERCENT MODULATION OF TONES (ALTERNATE) (cont'd)

12. Multiply value calculated in step 3 by 0.95 to obtain ac voltage required for 95% modulation.
13. Adjust Marker trim pot (R433) on PC-4 to obtain ac voltage indication equal to the value calculated in step 12.

#### PROCEDURE: VOR Tones

1. Set Frequency MODE Switch (1) to VOR XTL and Tone Select Switch (17) to CTR IN.
2. Adjust Master Mod Level Control (24) to CAL and the 9960 Hz Ref Level Control (23) full ccw.
3. Adjust the 30 Hz VAR Level Control (22) full cw and record dc voltage indicated (approx. 4 V). Define this voltage as VOR V2 and calculate the ac voltage required for 30% modulation using the following equation.

$$\text{Vac for 30\% modulation} = \frac{\text{VOR V2} - \text{VOR V1}}{1.414} \times 0.30$$

4. Adjust the 30 Hz VAR trim pot (R431) on PC-4 to obtain ac voltage indication equal to the voltage calculated in step 3.
5. Adjust the 30 Hz VAR Level Control (22) full ccw and the 9960 Hz Ref Level Control (23) full cw.
6. Record dc voltage indicated (approx. 4 V) and define it as VOR V2. Calculate Vac for 30% modulation by using equation in step 3.
7. Adjust the 9960 Hz trim pot (R432) on PC-4 to obtain ac voltage indication equal to the voltage calculated in step 6.
8. Adjust the 9960 Hz Ref Level Control (23) full ccw and set Tone Select Switch (17) to 1020.
9. Record dc voltage indicated (approx. 4 V) and define this voltage as VOR V2. Calculate ac voltage required for 30% modulation using the equation in step 3.
10. Adjust VOR Tone trim pot (R4087) on PC-4 to obtain ac voltage indication equal to the voltage calculated in step 9.

#### 4-9 PERCENT MODULATION OF TONES (ALTERNATE) (cont'd)

##### PROCEDURE: LOC Modulation and Centering

1. Set Frequency MODE Switch (1) to LOC XTL. Set LOC DDM Control (21) and G/S DDM Control (14) to 0.
2. Record dc voltage indicated (approx. 4 V) and define as LOC V2. Calculate ac voltage required for 20% modulation using the following equation:

$$\text{Vac for 20\% modulation} = \frac{\text{LOC V2} - \text{LOC V1}}{1.414} \times 0.20$$

3. Set G/S DDM Control (14) to 150 and adjust LOC trim pot (R454) on PC-4 to obtain ac voltage indication equal to that calculated in step 2.
4. Set G/S DDM Control (14) to 90 and adjust the LOC Centering Adjustment (19) to obtain ac voltage indication equal to that calculated in step 2.

##### PROCEDURE: G/S Modulation and Centering

1. Set Frequency MODE Switch (1) to G/S XTL, and LOC DDM Control (21) and G/S DDM Control (14) to 0.
2. Record dc voltage indicated (approx. 4 V) and define as G/S V2. Calculate ac voltage required for 40% modulation using the following equation:

$$\text{Vac for 40\% modulation} = \frac{\text{G/S V2} - \text{G/S V1}}{1.414} \times 0.40$$

3. Set LOC DDM Control (21) to 150 and adjust G/S trim pot (R482) on PC-4 to obtain ac voltage indication equal to that calculated in step 2.
4. Set LOC DDM Control (21) to 90 and adjust the G/S Centering Adjustment (15) to obtain ac voltage indication equal to that calculated in step 2.

##### PROCEDURE: COMM Modulation

1. Set Frequency MODE Switch (1) to COMM XTL and Tone Select Switch (17) to 1020.
2. Record dc voltage indicated (approx. 4 V) and define as COMM V2. Calculate ac voltage required for 30% modulation using the following equation:

#### 4-9 PERCENT MODULATION OF TONES (ALTERNATE) (cont'd)

$$\text{Vac for 30\% modulation} = \frac{\text{COMM V2} - \text{COMM V1}}{1.414} \times 0.30$$

3. Adjust COMM trim pot (R4010) on PC-4 to obtain ac voltage indication equal to that calculated in step 2.
4. Remove power from test set, reinstall PC-4 without PC Board Extender and reapply power.

---

#### 4-10 BEARING CHECK CIRCUIT

DESCRIPTION: This procedure is designed to verify the performance of the bearing generator at 90° and 270° and to provide front panel meter verification.

TEST EQUIPMENT: Oscilloscope  
Digital Voltmeter

#### PROCEDURE:

1. Set Frequency MODE Switch (1) to VOR XTL and Tone Select Switch (17) to CTR IN.
2. Adjust Master Mod Level Control (24) to CAL, and the 30 Hz VAR Level Control (22) and the 9960 Hz REF Level Control (23) full cw.
3. Adjust Tune Control (7) until Tune Indicator (6) is no longer illuminated. Press Fine Tune Switch (8) and adjust Tune Control (7) for minimum meter indication.
4. Connect oscilloscope to Signal Generator Demodulated Output Connector (B) and verify output to be a typical VOR signal.
5. Set Monitor Meter Function Switch (30) and Counter Mode Switch (3) to BRG.
6. Set VOR Bearing Select Switches (27) to 090.0 and VOR Bearing TO/FROM Switch (28) to TO.
7. Connect digital voltmeter to VOR Demodulated Output Test Point (TP-103) on PC-1.
8. Adjust Frequency trim pot (R118) on PC-1 to obtain voltmeter indication of 5.5 Vdc.

#### 4-10 BEARING CHECK CIRCUIT (cont'd)

9. Set Counter Mode Switch (3) to any position except BRG and allow test set to stabilize for several minutes.
10. Adjust Meter Bearing Centering Adjust (4) full cw.
11. Adjust R152 to position Monitor Meter (29) needle to right edge of scale.
12. Adjust Meter Bearing Centering Adjust (4) to position Monitor Meter (29) needle to center scale.
13. Set Counter Mode Switch (3) to BRG and allow meter movements to stop.
14. Alternately set VOR bearing TO/FROM Switch to the TO and FROM positions and adjust Phase trim pot (R128) to obtain same meter indication in both positions.
15. Adjust Balance trim pot (R150) for center scale meter indication.
16. Repeat steps 10 through 15 as necessary to obtain center scale meter indication.

#### NOTE

If the test set has a bearing error of more than 0.4 degrees, the above procedure can not be performed. Once adjusted, the bearing monitor circuit is intended to monitor the bearing output and quickly show if any deviation from normal operation exists.

---

#### 4-11 COMM POWER CIRCUIT

DESCRIPTION: This procedure checks the accuracy of the 100 W and 10 W COMM Power circuits.

TEST EQUIPMENT: RF Power Meter

#### PROCEDURE:

1. Set Monitor Meter Function Switch (30) to 100 W. Set Counter Mode Switch (3) to MHz position.
2. Connect an accurate thruline RF Power Meter to COMM Transmitter Input Connector (11) and apply 30 to 50 Watts of unmodulated RF power.

#### 4-11 COMM POWER CIRCUIT (cont'd)

NOTE See Table 1-1 in Section 1 for Input Power versus Time Limits. Exceeding time limits may cause internal damage to set and/or 25 dB pad.

3. Adjust the 100 W trim pot (R160) on PC-1 to obtain Monitor Meter (29) indication corresponding to power meter indication. Set Monitor Meter Function Switch (30) to 10 W.. Apply 4 to 8 watts of unmodulated RF power through power meter.
  4. Adjust the 10 W trim pot (R163) on PC-1 to obtain Monitor Meter (29) indication corresponding to power meter indication.
- 

#### 4-12 BATTERY CHARGER

**DESCRIPTION:** This procedure is used to check that proper battery charging voltage is provided during normal operation and that battery timer turns off set after desired delay.

**TEST EQUIPMENT:** 100 ohm, 20 watt resistor  
dc Voltmeter  
External Power Supply (14 to 16 volts)  
Stopwatch

#### PROCEDURE:

1. Disconnect red lead from battery and connect a 100 ohm, 20 watt resistor. Connect other resistor lead to ground. Connect dc voltmeter across resistor and apply ac power to test set.
2. Adjust Charge trim pot (R220) on PC-2 to obtain voltmeter indication of 16.1 Volts ( $\pm 0.1$  V).
3. Disconnect ac power cord from test set and replace resistor with external power supply (14 to 16 V). Set Monitor Meter Function Switch (30) to BAT.
4. Adjust Battery trim pot (R393) on PC-3 to obtain Monitor Meter (29) indication of power supply voltage on 0 to 30% scale.
5. Press AC/Battery Power Switch (25) to BAT and use stopwatch to check that battery timer turns off test set after 6 to 10 minutes. To change battery timer duration, increase values of R246 (10 M $\Omega$ ) or C214 (47  $\mu$ F) on PC-2 for longer delays or decrease values for shorter delays.

4-3 POWER SUPPLY VOLTAGES

|                           |         |       |         |
|---------------------------|---------|-------|---------|
| 11 V Regulator. . . . .   | 10.90 V | _____ | 11.10 V |
| 5 V Regulator . . . . .   | 4.90 V  | _____ | 5.00 V  |
| -6.2 V Regulator. . . . . | -6.00 V | _____ | -6.40 V |

4-4 TONES

|                                         |         |               |
|-----------------------------------------|---------|---------------|
| 1020 Hz Distortion. . . . .             | _____   | 1% max.       |
| 1020 Hz Frequency . . . . .             | 1015 Hz | _____ 1025 Hz |
| 1020 Hz Distortion. . . . .             | _____   | 1% max.       |
| 1020 Hz Frequency . . . . .             | 1015 Hz | _____ 1025 Hz |
| 400 Hz Frequency. . . . .               | 398 Hz  | _____ 402 Hz  |
| 1300 Hz Frequency . . . . .             | 1295 Hz | _____ 1305 Hz |
| 3000 Hz Frequency . . . . .             | 2985 Hz | _____ 3015 Hz |
| 2160 kHz Oscillator Frequency . . . . . | _____   | ±432 Hz       |
| 30 Hz VAR Distortion. . . . .           | _____   | <0.5%         |
| 30 Hz REF Distortion. . . . .           | _____   | <0.5%         |
| 9960 Hz Distortion. . . . .             | _____   | <1.5%         |
| Phase Lock Pulse Position . . . . .     | _____   | (✓)           |
| 9960 Hz Frequency . . . . .             | _____   | _____         |
| 480 Hz Deviation Δt . . . . .           | 46.1 μs | _____ 50.9 μs |
| 90 Hz Distortion. . . . .               | _____   | <0.5%         |
| 150 Hz Distortion . . . . .             | _____   | <0.5%         |

4-5 COUNTER CLOCK OSCILLATOR FREQUENCYWWV Zero Beat Calibration Method

Zero Beat . . . . . (✓)

Phase Lock Time Calibration Method

Output Frequency Error. . . . . (±0.0005%)

4-6 GENERATOR OUTPUT FREQUENCIES

|                                   |        |              |
|-----------------------------------|--------|--------------|
| 10.5 V Adjust . . . . .           | 10.4 V | _____ 10.6 V |
| MKR XTAL. . . . .                 | _____  | (±3 kHz)     |
| VOR XTAL. . . . .                 | _____  | (±5 kHz)     |
| LOC XTAL. . . . .                 | _____  | (±5 kHz)     |
| G/S XTAL. . . . .                 | _____  | (±16 kHz)    |
| COMM XTAL . . . . .               | _____  | (±6 kHz)     |
| MKR VAR Upper Limit . . . . .     | _____  | 78 MHz       |
| VOR VAR Upper Limit . . . . .     | _____  | 120 MHz      |
| COMM VAR HI Upper Limit . . . . . | _____  | 158 MHz      |
| COMM VAR LO Upper Limit . . . . . | _____  | 136 MHz      |
| COMM VAR LO Lower Limit . . . . . | _____  | 117 MHz      |
| COMM VAR HI Lower Limit . . . . . | _____  | 134 MHz      |
| LOC VAR Lower Limit . . . . .     | _____  | 107 MHz      |
| VOR VAR Lower Limit . . . . .     | _____  | 107 MHz      |
| MKR VAR Lower Limit . . . . .     | _____  | 72 MHz       |
| G/S VAR Lower Limit . . . . .     | _____  | 327 MHz      |

4-7 RF OUTPUT LEVEL

RF Level - MONITOR Meter Centering. . . . . (✓)

Attenuator Dial Setting (-30 dBm) . . . . . (✓)

## 4-8 PERCENT MODULATION OF TONES (PREFERRED)

|                    |       |     |
|--------------------|-------|-----|
| MONITOR Meter 100% | _____ | (✓) |
| MONITOR Meter 30%  | _____ | (✓) |
| 1020 Hz Tone       | _____ | 95% |
| 30 Hz VAR          | _____ | 30% |
| 9960 Hz REF        | _____ | 30% |
| 1020 Hz            | _____ | 30% |
| 150 Hz LOC         | _____ | 20% |
| LOC Centering      | _____ | (✓) |
| 150 Hz G/S         | _____ | 40% |
| G/S Centering      | _____ | (✓) |
| COMM Modulation    | _____ | 30% |

## 4-9 PERCENT MODULATION OF TONES (ALTERNATE)

|                                  |       |             |
|----------------------------------|-------|-------------|
| MKR V1                           | _____ | 260 mV app. |
| VOR V1                           | _____ | 260 mV app. |
| LOC V1                           | _____ | 260 mV app. |
| G/S V1                           | _____ | 300 mV app. |
| COMM V1                          | _____ | 260 mV app. |
| MRK V2                           | _____ | 4 V app.    |
| Vac for 100% Modulation          | _____ |             |
| MONITOR Meter 100%               | _____ | (✓)         |
| Vac for 30% Modulation           | _____ |             |
| MONITOR Meter 30%                | _____ | (✓)         |
| Vac for 95% Modulation           | _____ |             |
| Vac for 30% 30 Hz VAR Modulation | _____ |             |
| Vac for 30% 9960 Hz Modulation   | _____ |             |
| Vac for 30% 1020 Hz Modulation   | _____ |             |
| Vac for 20% LOC Modulation       | _____ |             |
| Vac for 40% G/S Modulation       | _____ |             |
| Vac for 30% COMM Modulation      | _____ |             |

## 4-10 BEARING CHECK CIRCUIT

|                                         |       |         |
|-----------------------------------------|-------|---------|
| MONITOR Meter Minimum                   | _____ | (✓)     |
| VOR Output                              | _____ | (✓)     |
| VOR Demodulated Output Voltage (TP-103) | _____ | 5.5 Vdc |
| MONITOR Meter Centering (Balance)       | _____ | (✓)     |

## 4-11 COMM POWER CIRCUIT

|                 |       |     |
|-----------------|-------|-----|
| 100 Watt Adjust | _____ | (✓) |
| 10 Watt Adjust  | _____ | (✓) |

## 4-12 BATTERY CHARGER

|                               |        |       |         |
|-------------------------------|--------|-------|---------|
| Battery Charger Voltage       | 16.0 V | _____ | 16.2 V  |
| Batt Voltage on MONITOR Meter | _____  |       | (✓)     |
| Battery Timer Operation       | _____  |       | (✓)     |
| Timer Duration                | 6 min. | _____ | 10 min. |

## 5 Troubleshooting

- 5-1 This section contains information to aid in isolating and repairing some common malfunctions which might occur in the test set. Table 6-1 lists all the test points on each printed circuit board. The Troubleshooting Chart, table 6-2, is a guide to help isolate malfunctions which might occur in each section of the test set.
- 5-2 The Troubleshooting Chart contains only the most common symptoms and probable causes and can not isolate every possible malfunction. Schematics are included, starting with figure 8-1, to aid in detailed troubleshooting and circuit analysis. The component placement for each printed circuit board is included with each schematic.
- 5-3 Because of the complexity of the Power Amplifier and Attenuator assemblies, factory assistance should be sought prior to attempting any repairs to these assemblies.

Table 6-1 Printed Circuit Board Test Points

| Test Points | Function                                                                                                                                                                                                          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TP101       | Bearing Check Board, PC-1<br>REF 30 Hz Sine Output<br>180° VAR 30 Hz Sine Output<br>VOR Demod Output<br>9960 Hz FM Oscillator Output<br>Phase Detector Output<br>0° VAR 30 Hz Sine Output<br>100 KHz Clock Output |
| TP102       |                                                                                                                                                                                                                   |
| TP103       |                                                                                                                                                                                                                   |
| TP104       |                                                                                                                                                                                                                   |
| TP105       |                                                                                                                                                                                                                   |
| TP106       |                                                                                                                                                                                                                   |
| TP107       |                                                                                                                                                                                                                   |
|             | Regulator-Timer Board, PC-2                                                                                                                                                                                       |
| TP201       | MKR Tone Oscillator Sine Output                                                                                                                                                                                   |
|             | Combination Sine Board, PC-3                                                                                                                                                                                      |
| TP301       | 90 Hz Sine Output                                                                                                                                                                                                 |
| TP302       | 150 Hz Sine Output                                                                                                                                                                                                |

Table 6-1 (cont.)

| Test Points | Function                      |
|-------------|-------------------------------|
| TP401       | 30 Hz Sine Board, PC-4        |
| TP402       | 30 Hz REF Sine Output         |
| TP403       | 9960 Hz FM Sine Output        |
|             | 30 Hz VAR Sine Output         |
| TP501       | VOR Bearing Logic Board, PC-5 |
| TP502       | 2160 Oscillator Output        |
| TP503       | 90 Hz Square Wave Output      |
| TP504       | 150 Hz Square Wave Output     |
| TP505       | 30 Hz REF Square Wave Output  |
| TP506       | Bearing Pick-Off              |
|             | 30 Hz VAR Square Wave Output  |

Table 6-2 TROUBLESHOOTING CHART

| Section                                    | Symptom                               | Possible Cause                                                                                                                                           |
|--------------------------------------------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power Supply                               | No +11 V output in ac operation.      | Fuse F1101 open.<br>CR1101 bad. Short to ground on +11 V supply line. Q224 open.                                                                         |
|                                            | No +11 V output in Battery operation. | Battery voltage too low; low voltage detector in operation.<br>K201 bad. - Coil or open contacts.<br>Short to ground on +11 V Supply line.<br>Q224 open. |
|                                            | +11 V output low.                     | High current load on +11 V supply line.<br>Current protect circuit in operation.                                                                         |
|                                            | No +5 V output.                       | Check F1101, CR1101.<br>Q1151 bad.<br>X1151 bad.<br>X1152 bad.<br>No negative voltage out from 5 V Regulator.                                            |
|                                            | No -6.2 V output.                     | (See No +5 V Output)<br>Check CR1151 & 1152.<br>Q213 open.<br>High current load on -6.2 V supply.<br>Q208 or Q209 bad.<br>CR1152 or CR1153 open.         |
|                                            | No Tone output.                       | X201 or X202 bad.<br>Q216, Q217, Q214 or Q215 bad.<br>Short on output line to ground.                                                                    |
| 1020, 400, 1300 and 3000 Hz Tone Generator | Frequencies not proper.               | X201 or X202 bad (Check for offset output voltage level).<br>Q216, Q217, Q214 or Q215 not saturating completely.<br>C209 bad.                            |

Table 6-2 (cont'd)

| Section                                                   | Symptom                                                         | Possible Cause                                                                                                                                                                                                                           |
|-----------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1020, 400, 1300<br>and 3000 Hz Tone<br>Generator (cont'd) | Distortion on output<br>frequency.                              | Check triangular wave<br>at input to R270.<br>(2.1 K $\Omega$ 1%). One of<br>the stages of the<br>synthesizer is bad.<br>Check for voltages<br>indicated on schematic.<br>Check for DC level on<br>output of synthesizer<br>to be 5.5 V. |
| VOR BRG Generator<br>90 Hz and 150 Hz<br>Tones            | Output 30 Hz Ref or<br>30 Hz VAR not at cor-<br>rect frequency. | Check frequency at<br>TP501. Should be 2.16<br>MHz $\pm 0.02\%$ . If not:<br>Check Y501<br>Check X505                                                                                                                                    |
|                                                           | 30 Hz REF.                                                      | Division of X511,<br>X514, X519, X518,<br>X517, X516 wrong.<br>Check X511.                                                                                                                                                               |
|                                                           | 30 Hz VAR.                                                      | Division of X508,<br>X507, X506, or control<br>X509, X510 or X520 bad.                                                                                                                                                                   |
|                                                           | 30 Hz REF output at<br>TP504 not symmetrical.                   | Reset in 30 Hz REF<br>counter inoperative.<br>X512, X510, X513, or<br>X511 bad.                                                                                                                                                          |
|                                                           | No 30 Hz VAR signal.                                            | X504 bad.<br>X509 or X520 bad.<br>X510 bad.<br>X505 bad.                                                                                                                                                                                 |
|                                                           | No 30 Hz VAR signal<br>at 0° Switch setting.                    | X505 bad.<br>X504 bad.                                                                                                                                                                                                                   |
|                                                           | Bearing Switches<br>select incorrect<br>headings.               | Check diodes CR501<br>through CR512. Isolate<br>which line is bad.                                                                                                                                                                       |

Table 6-2 (cont'd)

| Section                                                                                                                                                                                    | Symptom                                          | Possible Cause                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| VOR BRG Generator<br>90 Hz and 150 Hz<br>Tones (cont'd)                                                                                                                                    |                                                  | (1,2,4, or 8) is causing the wrong bearing.<br>X504 bad.                                                                 |
|                                                                                                                                                                                            | 90 Hz frequency wrong.                           | X515 bad - Check for division by 12.<br>Input to X515 wrong.<br>Check freq at TP501 and X511, X514, X519, X518, X510.    |
|                                                                                                                                                                                            | 150 Hz frequency wrong.                          | X503 or X502 bad.<br>X501 bad.<br>Input to X503 wrong.                                                                   |
|                                                                                                                                                                                            | No phase shift between 90 Hz and 150 Hz signals. | X510 bad.<br>S9 input broken.<br>30 Hz VAR system inoperative.                                                           |
| 30 Hz REF and 30 Hz<br>VAR Sine Output                                                                                                                                                     | No 30 Hz sine output.                            | Check for square wave input at PC4-4.<br>Q401, Q402, or Q403 bad.<br>X401 bad. Short to ground on output of synthesizer. |
| NOTE: The 30 Hz REF and 30 Hz VAR synthesizers are identical. Possible causes are given for REF section only. Refer to the corresponding component if problems occur in the 30 Hz section. | Distortion on 30 Hz sine wave.                   | X401 not centered.<br>X401 bad.<br>One of the stages of synthesizer bad.<br>Check voltages according to schematic.       |
|                                                                                                                                                                                            | No 9960 Hz output.                               | X405, X406, or X407 bad.<br>Q409 and Q410 bad.<br>Q409 or Q410 have poor saturation characteristic. Q408 bad.            |

Table 6-2 (cont'd)

| Section                                                                                                                                      | Symptom                             | Possible Cause                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30 Hz REF and 30 Hz<br>VAR Sine Output<br>(cont'd)                                                                                           | 9960 at wrong frequency.            | Check operation of Q409, Q410, X405, X406 or X407.                                                                                                            |
|                                                                                                                                              | No 9960 Hz phase lock.              | Check CR458. Q404 or Q405 bad. Q406, Q407 bad. X403 or X404 bad. Check CR454-CR457.                                                                           |
|                                                                                                                                              | No FM modulation of 9960 Hz signal. | 30 Hz REF sine output inoperative.                                                                                                                            |
|                                                                                                                                              | FM deviation improper.              | X405A bad. Check offset voltage. CR417, CR418, or CR419 bad. Q401 bad. Check R434 and R435 value.                                                             |
|                                                                                                                                              | Distortion on 9960 Hz sine output.  | X406 output wrong. Check P-P amplitude on pin 1 of X406.<br><br>Check offset voltage. Heavy load at output. Check sine synthesizer. +5.5 V supply not proper. |
| 90 Hz and 150 Hz<br>Sine Output<br><br>NOTE: The 90 Hz and 150 Hz sine Generators are identical. Causes are given for the 90 Hz system only. | No 90 Hz output.                    | No 90 Hz square wave input.<br>Q308 bad.<br>Q303 or Q305 bad.<br>X305 bad.<br>C303 bad.                                                                       |
|                                                                                                                                              | Distortion on 90 Hz output.         | X305 bad.<br>One stage of sine synthesizer bad.<br>Centering to X305 wrong. Check R312.                                                                       |

Table 6-2 (cont'd)

| Section                               | Symptom                                                                               | Possible Cause                                                                                              |
|---------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| 90 Hz and 150 Hz Sine Output (cont'd) | No G/S 90 Hz sine output.                                                             | X307 bad.<br>R6 input broken.                                                                               |
|                                       | No LOC 90 Hz sine output.                                                             | X308 bad.<br>R4 input broken.                                                                               |
|                                       | No LOC and G/S 150 Hz.                                                                | X309 bad.                                                                                                   |
| Tones to Mode Switch                  | None of the tones present at NAV tone output jack J1101.                              | Q307, Q301, or Q302 bad.<br>X303 bad.<br>X301 bad.<br>Short to ground at output jack.                       |
|                                       | Tones present on Signal Generator Demod jack, J1104, but not on NAV tones out, J1101. | X301 bad or broken connection.                                                                              |
| 1020, 400, 1300, 3000 Hz Tones        | No tones out.                                                                         | Check wiring to S7A (tone output) or S7B (tone select).<br>X402 bad.                                        |
| VOR Tones                             | No tones out.                                                                         | No 5.5 V to center of R2 and R3.                                                                            |
|                                       | No Ident tone on VOR signal.                                                          | X402 bad.<br>Ident Tone Generator inoperative.                                                              |
| LOC Tones                             | No LOC tone to Ident tone.                                                            | X402 bad.                                                                                                   |
| G/S Tones<br>COMM Tones               | No G/S tone.                                                                          | X407 bad.                                                                                                   |
|                                       | No COMM tone.                                                                         | X402 bad.<br>Check wiring on Mode Switch.                                                                   |
| Counter Clock Oscillator Frequency    | No 100 kHz output to Counter Board.                                                   | Oscillator inoperative.<br>Check Oscillator at collector of Q106.<br>X110 or X111 bad.<br>Q107 or Q108 bad. |

Table 6-2 (cont'd)

| Section                                     | Symptom                                                      | Possible Cause                                    |
|---------------------------------------------|--------------------------------------------------------------|---------------------------------------------------|
| Counter Clock Oscillator Frequency (cont'd) | Oscillator inoperative.                                      | Q105 or Q106 bad.<br>Y101 crystal bad.            |
|                                             | Frequency will not zero to exactly 10 MHz.                   | Check Y101.<br>Q105 or Q106 bad.<br>C125 bad.     |
| Generator Output Frequencies                | Marker XTAL off frequency.                                   | Y704 bad.<br>L710 needs adjustment.<br>Q709 bad.  |
|                                             | No MKR output on XTAL.                                       | Y704 bad.<br>Q709 bad.                            |
|                                             | VOR XTAL off frequency.                                      | Y705 bad.<br>L711 needs adjustment.<br>Q710 bad.  |
|                                             | No VOR output on XTAL.                                       | Y705 bad.<br>Q710 bad.                            |
|                                             | LOC XTAL off frequency.                                      | Y703 bad.<br>L714 needs adjustment.<br>Q708 bad.  |
|                                             | No LOC output on XTAL.                                       | Y703 bad.<br>Q708 bad.                            |
|                                             | G/S XTAL off frequency.                                      | Y701 bad.<br>L712 needs adjustment.<br>Q706 bad.  |
|                                             | No G/S output on XTAL.                                       | Y701 bad.<br>Q706 bad.                            |
|                                             | COMM XTAL off frequency.                                     | Y702 bad.<br>L713 needs adjustment.<br>Q707 bad.  |
|                                             | No COMM output on XTAL.                                      | Y702 bad.<br>Q707 bad.                            |
|                                             | None of the frequency modes extends low enough in frequency. | Low limit pot R745 should be reset.<br>CR705 bad. |

Table 6-2 (cont'd)

| Section                                                                                                                          | Symptom                                                            | Possible Cause                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Generator Output<br>Frequencies (cont'd)                                                                                         | None of the frequency modes extend high enough in frequency.       | Follow the procedure as described in the Calibration Procedures, paragraph 4-6.                                |
|                                                                                                                                  | VOR, LOC, G/S VAR band does not have broad enough frequency range. | Adjust L705 and low frequency pot R745 as required.                                                            |
|                                                                                                                                  | MKR, VAR band does not have broad enough frequency range.          | Adjust L703 and low frequency pot R745 as required.                                                            |
|                                                                                                                                  | LO COMM band needs more frequency range.                           | Adjust L705 and low frequency pot R745 as required.                                                            |
|                                                                                                                                  | HI COMM band needs more frequency range.                           | Adjust L706 and low frequency pot R745 as required.                                                            |
| NOTE: Above frequency adjustment affects the other bands so it is necessary to check all other VAR bands after every adjustment. |                                                                    |                                                                                                                |
| Phase Lock Section                                                                                                               | No RF output at J702.                                              | Q704 or Q705 bad.                                                                                              |
|                                                                                                                                  | FM on RF output.                                                   | 10.5 V Regulator bad.<br>11 V Regulator bad.<br>X701, Q703 or CR712 bad.                                       |
|                                                                                                                                  | No Phase Lock.                                                     | No input to Assembly 4 from Prescaler.<br>No input to Assembly 4 from Counter.<br><br>No +11 V input from S12. |
|                                                                                                                                  | Phase Lock difficult to achieve.                                   | Q954 or Q955 leaky.<br>Q953 bad.                                                                               |

Table 6-2 (cont'd)

| Section            | Symptom                                         | Possible Cause                                                                                                                                                                                                                        |
|--------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RF Output Level    | Low RF output.                                  | Check Diodes CR1 through CR4 in Diode protect block.<br>P.A. not properly tuned.<br>X802 bad.<br>Q804 bad.<br><br>NOTE: If X802 is defective, the tune lamp may not go out.<br><br>Q805 through Q809 is bad (depending on band used). |
|                    | Tune Lamp will not extinguish.                  | Q801, Q802, or Q803 bad.<br>No RF to XMTR X801 or X802 bad.<br>Overmodulation.<br>Input RF frequency out of bandwidth of tune frequency.<br>No RF in.<br>Check Buffer amp out.                                                        |
|                    | Tune lamp will not illuminate.                  | Q801, Q802, Q803 bad.<br>Defective bulb.                                                                                                                                                                                              |
|                    | Meter does not indicate in white band on meter. | P.A. not properly tuned.<br>R386 needs adjustment.                                                                                                                                                                                    |
| Percent Modulation | No % Modulation Meter indication.               | X304 bad.<br>X302 bad.<br>P.A. not in proper tune.<br>No modulation being applied to modulator.                                                                                                                                       |

Table 6-2 (cont'd)

| Section                        | Symptom                                         | Possible Cause                                                                                                                                           |
|--------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Percent Modulation<br>(cont'd) | % Mod reads too high.                           | Input tone distorted to modulator by large amount.<br>Check Tone Out.<br>One of the FET Switch Q805 through Q809 shorted.                                |
|                                | % Mod reads too low.                            | Input tone to modulator low in level.<br>Q805 through Q809 bad.<br>X304 bad.<br>X302 bad.                                                                |
|                                | 100% scale and 30% scale do not agree together. | R389 or R391 probably out of adjustment.<br>Q307 bad.<br>Q302 bad.                                                                                       |
| LOC and G/S Centering          | Not able to center LOC or G/S.                  | Amplitude of 90 Hz sine output too high, or low.                                                                                                         |
|                                |                                                 | Amplitude of 150 Hz sine output too high or low.<br>X309 bad.<br>LOC X308 bad.<br>G/S X307 bad.                                                          |
| Bearing Check Circuit          | No VOR Demod at TP103.                          | X101 or X102 bad.<br>9960 Hz oscillator inoperative. Check: X104 or X105, Q103 or Q104.<br><br>Phase Lock loop inoperative. Check: X102<br>Q101<br>Q102. |

Table 6-2 (cont'd)

| Section                           | Symptom                                      | Possible Cause                                                                                                                                                                                                            |
|-----------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bearing Check circuit<br>(cont'd) | No 30 Hz at TP101.                           | No 30 Hz output at TP103.<br>X101 bad.<br>X102 bad.                                                                                                                                                                       |
|                                   | No 0° VAR at TP106.                          | X106 bad.<br>X101 bad.                                                                                                                                                                                                    |
|                                   | No 180° VAR at TP102.                        | X107 bad.                                                                                                                                                                                                                 |
|                                   | No detector voltage at TP105.                | X106 bad.<br>CR106-CR109 bad.                                                                                                                                                                                             |
|                                   | Unable to center meter.                      | X109 bad.<br>Balance Adjust R150,<br>Phase Adjust R128<br>or Trim Adjust R152<br>need resetting.<br>No 30 Hz VAR input to<br>circuit (PC-1).<br>No 9960 Hz input to<br>circuit (PC-1).<br>-6.2 V or +11 V not<br>present. |
|                                   | Bearing error.                               | C403 and C412 bad<br>or leaky.<br>X401 and X408 bad.                                                                                                                                                                      |
| Power Meter                       | No power indication on meter.                | CR901 bad.<br>CR902 bad.<br>X901 bad.                                                                                                                                                                                     |
|                                   | Power meter reading low.                     | 25 dB pad damaged.<br>CR901 bad.<br>R160 and R163<br>need adjustment.                                                                                                                                                     |
|                                   | Meter does not indicate peak power readings. | C903 bad.<br>Wiring to S10 open.                                                                                                                                                                                          |
|                                   |                                              |                                                                                                                                                                                                                           |

Table 6-2 (cont'd)

| Section              | Symptom                                                 | Possible Cause                                                                                                    |
|----------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Power Meter (cont'd) | Power Meter pegs without any input.                     | X901 bad.<br>CR901 bad.<br>R905 can be adjusted.                                                                  |
|                      | Power Meter reads, but Counter does not read frequency. | No prescaler output.<br>Input to prescaler may be shorted.                                                        |
| Counter Operation    | No count in GEN mode.                                   | No prescaler input.<br>No clock input from PC-1.                                                                  |
|                      | No count in external mode.                              | No input to pre-scaler from front panel.<br>Preacaler defective.<br>Q1001 or Q1004 bad.<br>X1008 bad.             |
|                      | No count in bearing mode.                               | Q501 bad.<br>X504 bad.<br>X509 bad.<br>No 30 Hz reference signal to counter.                                      |
|                      | No count in either generator or external modes.         | Time base dividers bad.<br>Check X622 through X628, X624 or X625 bad.<br>Check X615 through X620 for error.       |
|                      | Wrong readout for known frequency input.                | Check X615 through X620. Problem could be in readout circuit<br>Check X609 through X614. Check X603 through X608. |
|                      | Wrong count in G/S mode.                                | No +11 V at Pin 14.<br>X601 or X602 bad.<br>X621 bad.                                                             |
|                      |                                                         |                                                                                                                   |

Table 6-2 (cont'd)

| Section                       | Symptom                                            | Possible Cause                                                                                                  |
|-------------------------------|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Counter Operation<br>(cont'd) | Segment of readout bad.                            | Check the respective driver<br>X603 through X608.                                                               |
|                               | Display time control inoperative                   | CR603 bad.<br>Q601 bad.<br>Q602 bad.                                                                            |
| Battery Charger               | Battery does not maintain proper charge condition. | One or more cells of the battery bad.<br>Q218, Q219, or Q220 bad.<br>Q223 Regulator bad.<br>CR207 or CR208 bad. |
|                               | Battery overheats during charging.                 | Charger not current limiting.<br>Q218, Q219, or Q220 bad.<br>Check CR205 through CR208.                         |
| Battery Timer                 | Timer will not start.                              | K201 bad.<br>Check CR211 through CR213.                                                                         |
|                               | Timer starts but turns off in a short time.        | Q205 bad.<br>Battery voltage low.<br>CR211 bad.<br>CR214 bad.<br>Check Q201 through Q203.                       |
|                               | Timer will not manually turn off.                  | CR213 open.                                                                                                     |
|                               | Low Voltage Cutoff inoperative.                    | Q204 bad.                                                                                                       |
|                               | No pilot light.                                    | Defective bulb.<br>No 5 V applied to lamp.                                                                      |
|                               |                                                    |                                                                                                                 |

## SECTION 7

### 7-1. Introduction.

7-2. This section is designed to aid the technician in trouble-shooting by providing pin-outs of the I.C.s used in the test set. Truth tables have also been supplied for some of the more functionally complex types of logic circuits. Positive logic is used throughout.

7-3. The following is a list of the symbols used in the truth tables and brief definitions of the symbols:

- X - don't care, status of input irrelevant
- S - output stays the same, doesn't change
- H - high logic level
- L - low logic level
- ↑ - transition from low to high logic level, positive edge triggering occurs
- ↓ - transition from high to low logic level, negative edge triggering occurs
- U - unstable, this output will decay to another logic level.

Toggle - The outputs change to their complementary logic levels

-  - one high level pulse
-  - one low level pulse

### 7-4. Types of Logic Gates.

7-5. Basically, there are eight types of logic gates: buffers, inverters, OR, NOR, XOR (exclusive OR), AND, NAND and the Data Selector.

7-6. The buffer is used to improve fanout, condition pulses, etc. The buffer is schematically represented as:



The truth table of the buffer is :

| Input | Output |
|-------|--------|
| H     | H      |
| L     | L      |

7-7. This inverter is similar to the buffer except that, the output is the logical complement of the input. The inverter is schematically represented as:



The truth table of the inverter is:

| Input | Output |
|-------|--------|
| H     | L      |
| L     | H      |

7-8. The OR gate performs the logical OR function. If any input goes high, the output is high. The output is low only when both inputs are low. The OR gate is represented schematically as:



The truth table of the OR gate is

| Inputs |   | Output |
|--------|---|--------|
| 1      | 2 |        |
| L      | L | L      |
| L      | H | H      |
| H      | L | H      |
| H      | H | H      |

7-9. The NOR or  $\overline{\text{OR}}$  gate performs the logical NOR function. If any input goes high, the output is low. The output is high only when both inputs are low. The NOR gate is represented schematically as:



The truth table of the NOR gate is:

| Inputs |   | Output |
|--------|---|--------|
| 1      | 2 |        |
| L      | L | H      |
| L      | H | L      |
| H      | L | L      |
| H      | H | L      |

7-10. The output of the EXCLUSIVE OR or XOR gate goes high when one and only one of the inputs are high. The output of the XOR gate is low when both inputs are high. The XOR gate is represented schematically as:



The truth table of XOR gate is:

| Inputs |   | Output |
|--------|---|--------|
| 1      | 2 |        |
| L      | L | L      |
| L      | H | H      |
| H      | L | H      |
| H      | H | L      |

7-11. The output of the AND gate goes high only when all of the inputs are high. The AND gate is represented schematically as:



The truth table of the AND gate is:

| Inputs |   | Output |
|--------|---|--------|
| 1      | 2 |        |
| L      | L | L      |
| L      | H | L      |
| H      | L | L      |
| H      | H | H      |

7-12. The output of the NAND or  $\overline{\text{AND}}$  gate goes low only when all of the inputs are high. The NAND gate is represented schematically as:



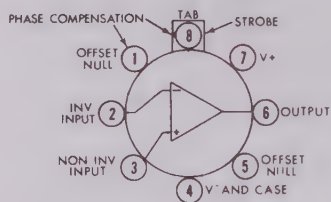
The truth table of the NAND gate is:

| Inputs |   | Output |
|--------|---|--------|
| 1      | 2 |        |
| L      | L | H      |
| L      | H | H      |
| H      | L | H      |
| H      | H | L      |

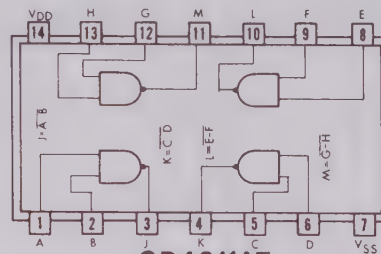
7-13. The Data Selector can be considered as a solid state switch. The desired input(s) is chosen by activating the appropriate SELECT input(s). This enables data from the selected input(s) to be made available at the output pin(s) of the Data Selector.



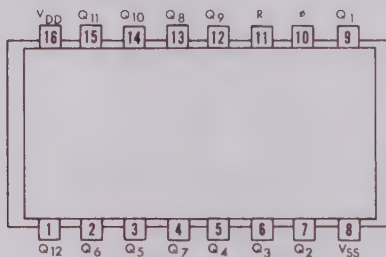
# INTEGRATED CIRCUIT GUIDE



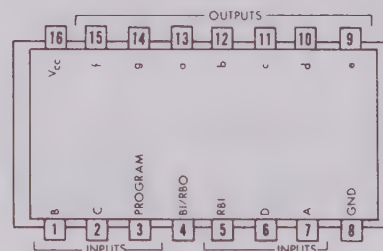
**CA3130**  
**OP AMP**



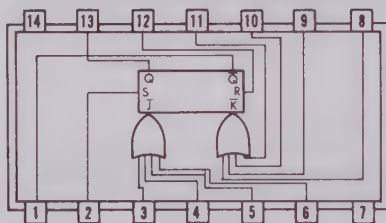
**CD4011AE**  
**COS/MOS**  
**QUAD 2 INPUT NAND**



**CD4040AE**  
**RIPPLE BINARY**  
**COUNTER/DIVIDER**



**DD-700/DM8880**  
**DECODER DRIVER**



**MC1027**  
**AC-COUPLED J-K FLIP FLOP**

**R-S OPERATION**

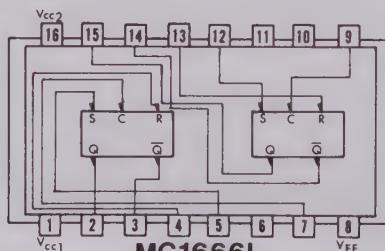
| R | S | Q <sup>n+1</sup> |
|---|---|------------------|
| 0 | 1 | 1                |
| 1 | 0 | 0                |
| 0 | 0 | Q <sup>n</sup>   |
| 1 | 1 | N.D.             |

All J-K inputs are static  
N.D. = Not defined

**CLOCKED J-K OPERATION**

| J | K | C <sub>D</sub> | Q <sup>n+1</sup> |
|---|---|----------------|------------------|
| 0 | 0 | 0              | Q <sup>n</sup>   |
| 0 | 1 | 0              | 0                |
| 1 | 0 | 0              | 1                |
| 1 | 1 | 0              | Q <sup>n</sup>   |

0 = Don't Care

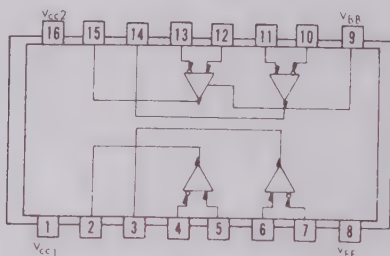


**MC1666L**  
**DUAL CLOCKED R-S**  
**FLIP FLOP**

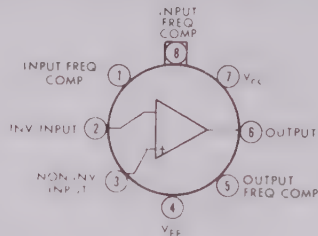
| S | R | C | Q <sub>n+1</sub> |
|---|---|---|------------------|
| 0 | 0 | 0 | Q <sub>n</sub>   |
| 0 | 0 | 1 | Q <sub>n</sub>   |
| 1 | 0 | 1 | 1                |
| 0 | 1 | 1 | 0                |
| 1 | 1 | 1 | N.D.             |

0 = Don't Care  
N.D. = Not Defined

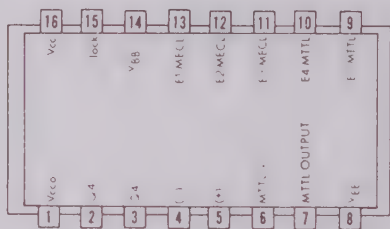
# INTEGRATED CIRCUIT GUIDE



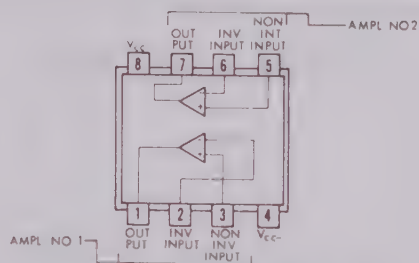
**MC1692L**  
**QUAD LINE RECEIVER**



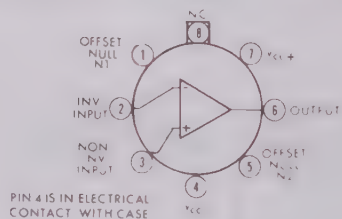
**MC1709CG/LM709H**  
**OP. AMP.**



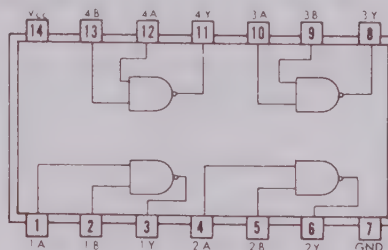
**MC12013**  
**TWO-MODULUS PRESCALER**



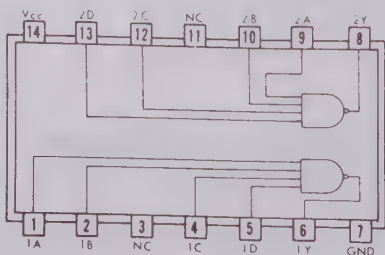
**SN72558/MC1458**  
**OP. AMP.**



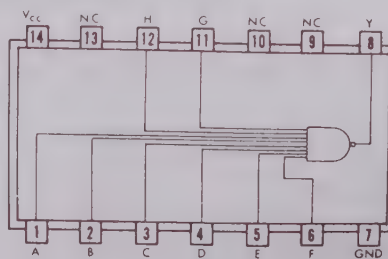
**SN72741**  
**OP. AMP.**



**7400**  
**2 INPUT NAND GATE**

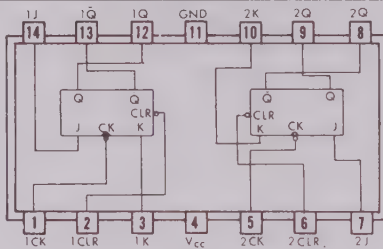


**SN7420**  
**QUAD INPUT NAND**



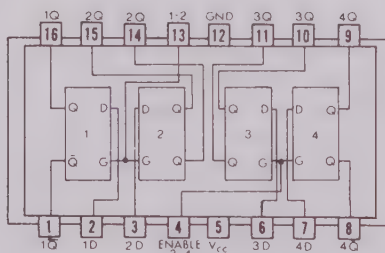
**SN7430**  
**8 INPUT POSITIVE NAND GATE**

# INTEGRATED CIRCUIT GUIDE

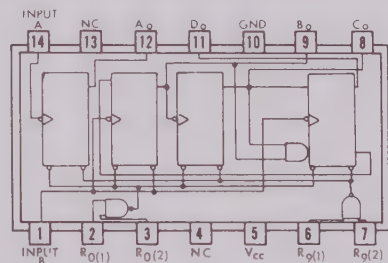


**7473**  
**DUAL J-K FLIP-FLOP**

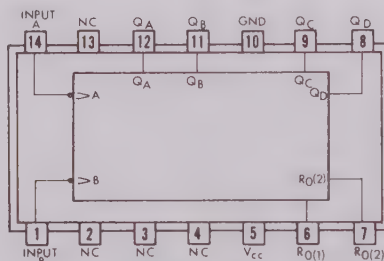
| INPUTS |       |   |   | OUTPUTS |           |
|--------|-------|---|---|---------|-----------|
| CLEAR  | CLOCK | J | K | Q       | $\bar{Q}$ |
| L      | X     | X | X | L       | H         |
| H      |       | L | L | S       | S         |
| H      |       | H | L | H       | L         |
| H      |       | L | H | L       | H         |
| H      |       | H | H | TOGGLE  |           |



**7475**  
**4-BIT LATCH**



**7490**  
**DECODER COUNTER**



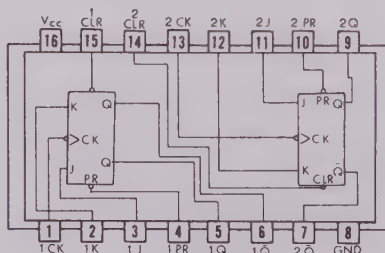
**SN7492**  
**DIVIDE-BY-TWELVE COUNTER**

**COUNT SEQUENCE**

| COUNT | OUTPUT         |                |                |                |
|-------|----------------|----------------|----------------|----------------|
|       | Q <sub>D</sub> | Q <sub>C</sub> | Q <sub>B</sub> | Q <sub>A</sub> |
| 0     | L              | L              | L              | L              |
| 1     | L              | L              | L              | H              |
| 2     | L              | L              | H              | L              |
| 3     | L              | L              | H              | H              |
| 4     | L              | H              | L              | L              |
| 5     | L              | H              | L              | H              |
| 6     | H              | L              | L              | L              |
| 7     | H              | L              | L              | H              |
| 8     | H              | L              | H              | L              |
| 9     | H              | L              | H              | H              |
| 10    | H              | H              | L              | L              |
| 11    | H              | H              | L              | H              |

**RESET/COUNT FUNCTION TABLE**

| RESET INPUTS       |                    | OUTPUTS        |                |                |                |
|--------------------|--------------------|----------------|----------------|----------------|----------------|
| R <sub>0</sub> (1) | R <sub>0</sub> (2) | Q <sub>D</sub> | Q <sub>C</sub> | Q <sub>B</sub> | Q <sub>A</sub> |
| H                  | H                  | L              | L              | L              | L              |
| L                  | X                  | COUNT          |                |                |                |
| X                  | L                  | COUNT          |                |                |                |



**74S112**  
**DUAL J-K FLIP-FLOP**

| INPUTS |       |       |   |   | OUTPUTS |           |
|--------|-------|-------|---|---|---------|-----------|
| PRESET | CLEAR | CLOCK | J | K | Q       | $\bar{Q}$ |
| L      | H     | X     | X | X | H       | L         |
| H      | L     | X     | X | X | L       | H         |
| L      | L     | X     | X | X | U       | U         |
| H      | H     |       | L | L | S       | S         |
| H      | H     |       | H | L | H       | L         |
| H      | H     |       | L | H | L       | H         |
| H      | H     |       | L | H | L       | H         |
| H      | H     |       | H | H | TOGGLE  |           |
| H      | H     | H     | X | X | S       | S         |







## NAV-401L

## TABLE OF CONTENTS

## SCHEMATICS

## SECTION 8

| <u>Figure</u> |                                                                                                       | <u>Page</u> |
|---------------|-------------------------------------------------------------------------------------------------------|-------------|
| 8-1           | Interconnect Diagram<br>(Eff: S/N 1171 thru 2214, 2218 thru 2271) .....                               | 8-1         |
| 8-1-1         | Interconnect Diagram<br>(Eff: S/N 2215 thru 2217, 2272 & on) .....                                    | 8-2         |
| 8-2           | Bearing Check Board Parts Layout .....                                                                | 8-3         |
| 8-3           | Bearing Check Board Schematic .....                                                                   | 8-5         |
| 8-4           | Regulator-Timer Board Parts Layout .....                                                              | 8-7         |
| 8-5           | Regulator-Timer Board Schematic .....                                                                 | 8-9         |
| 8-6           | Combination Sine Board Parts Layout .....                                                             | 8-11        |
| 8-7           | Combination Sine Board Schematic .....                                                                | 8-13        |
| 8-8           | 30 Hz Sine Board Parts Layout .....                                                                   | 8-15        |
| 8-9           | 30 Hz Sine Board Schematic .....                                                                      | 8-17        |
| 8-10          | VOR Bearing Logic Board Parts Layout .....                                                            | 8-19        |
| 8-11          | VOR Bearing Logic Schematic .....                                                                     | 8-21        |
| 8-12          | Counter Board Parts Layout .....                                                                      | 8-23        |
| 8-13          | Counter Schematic .....                                                                               | 8-25        |
| 8-14          | High Voltage Power Supply Board Parts Layout .....                                                    | 8-27        |
| 8-15          | High Voltage Power Supply Schematic .....                                                             | 8-29        |
| 8-16          | Buffer Amp Board Parts Layout .....                                                                   | 8-31        |
| 8-17          | Buffer Amp Schematic .....                                                                            | 8-33        |
| 8-18          | Prescaler Schematic (401L Eff: to S/N 2215, 2218<br>thru 2271. 402AP Eff: thru S/N 227) .....         | 8-35        |
| 8-19          | Prescaler Board Parts Layout (401L Eff: S/N 2215<br>thru 2217, 2272 & on. 402AP Eff: S/N 228 & on) .. | 8-37        |
| 8-20          | Prescaler Schematic (401L Eff: S/N 2215 thru 2217,<br>2272 & on. 402AP Eff: S/N 228 & on) .....       | 8-39        |
| 8-21          | Phase Lock/Power Monitor Board Parts Layout .....                                                     | 8-41        |
| 8-22          | Phase Lock/Power Monitor Schematic .....                                                              | 8-43        |
| 8-23          | Oscillator Board Parts Layout .....                                                                   | 8-45        |
| 8-24          | Oscillator Schematic .....                                                                            | 8-47        |
| 8-25          | Transmitter, Modulator & Tripler Board Parts<br>Layout .....                                          | 8-48        |
| 8-26          | Modulator PC & Attenuator Assembly Schematic .....                                                    | 8-49        |
| 8-27          | Localizer Transmitter Board Parts Layout .....                                                        | 8-51        |
| 8-28          | Localizer Transmitter Schematic .....                                                                 | 8-53        |
| 8-29          | 5 Volt Regulator Parts Layout .....                                                                   | 8-55        |
| 8-30          | 5 Volt Regulator Schematic .....                                                                      | 8-57        |
| 8-31          | AC Power Supply Parts Layout .....                                                                    | 8-59        |
| 8-32          | AC Power Supply Schematic .....                                                                       | 8-61        |
| 8-33          | Bearing Correction Circuit Schematic<br>(Installed at Manufacturer's Option) .....                    | 8-63        |
| 8-34          | +20 dB External Amp PC Board .....                                                                    | 8-65        |

NAV-401L  
TABLE OF CONTENTS  
PARTS LIST

| SECTION 9                                            | <u>Page</u> |
|------------------------------------------------------|-------------|
| 9-1 Introduction .....                               | 9-1         |
| 9-3 Front Panel Assembly .....                       | 9-3         |
| 9-4 Digital Counter Assembly .....                   | 9-7         |
| 9-5 . Counter Board Assembly .....                   | 9-9         |
| 9-6 . High Voltage Power Supply .....                | 9-11        |
| 9-7 Power Supply Assembly .....                      | 9-13        |
| 9-8 PC Card Cage Assembly .....                      | 9-15        |
| 9-9 . Bearing Check Board Assembly (PC-1) .....      | 9-17        |
| 9-10 . Regulator/Timer Board Assembly (PC-2) .....   | 9-19        |
| 9-11 . Combination Sine Board Assembly (PC-3) .....  | 9-21        |
| 9-12 . 30 Hz Sine Board Assembly (PC-4) .....        | 9-23        |
| 9-13 . VOR Bearing Logic Board Assembly (PC-5) ..... | 9-25        |
| 9-14 5 Volt Regulator Assembly .....                 | 9-27        |
| 9-15-1 Prescaler Assembly .....                      | 9-29        |
| (Eff: to S/N 2215, S/N 2218-2271)                    |             |
| 9-15-2 (Eff: S/N 2215-2217, 2272 and on) .....       | 9-31        |
| 9-16 Oscillator Assembly .....                       | 9-33        |
| 9-17 Phase-Lock Range Extender .....                 | 9-35        |
| 9-18 Buffer Amp Assembly .....                       | 9-37        |
| 9-19 Phase-Lock Power Monitor Assembly .....         | 9-39        |
| 9-20 Attenuator/Transmitter Assembly .....           | 9-41        |
| 9-21 Localizer/Transmitter Assembly .....            | 9-45        |
| 9-22 Diode Protect Block Assembly .....              | 9-47        |
| 9-23 160 MHz Low Pass Filter Assembly .....          | 9-49        |
| 9-24 RF Cable Assemblies .....                       | 9-51        |
| 9-25 Case Assembly .....                             | 9-53        |

NAV-401L  
TABLE OF CONTENTS  
MECHANICAL

SECTION 10

| <u>Table</u>                             | <u>Page</u> |
|------------------------------------------|-------------|
| 10-1 Mechanical Breakdown Index          | 10-5        |
| <u>Figure</u>                            | <u>Page</u> |
| 10-1 Mechanical Breakdown                | 10-1        |
| 10-1-1 Mechanical Breakdown Detail Views | 10-3        |
| 10-2 Rear View of Front Panel            | 10-6        |























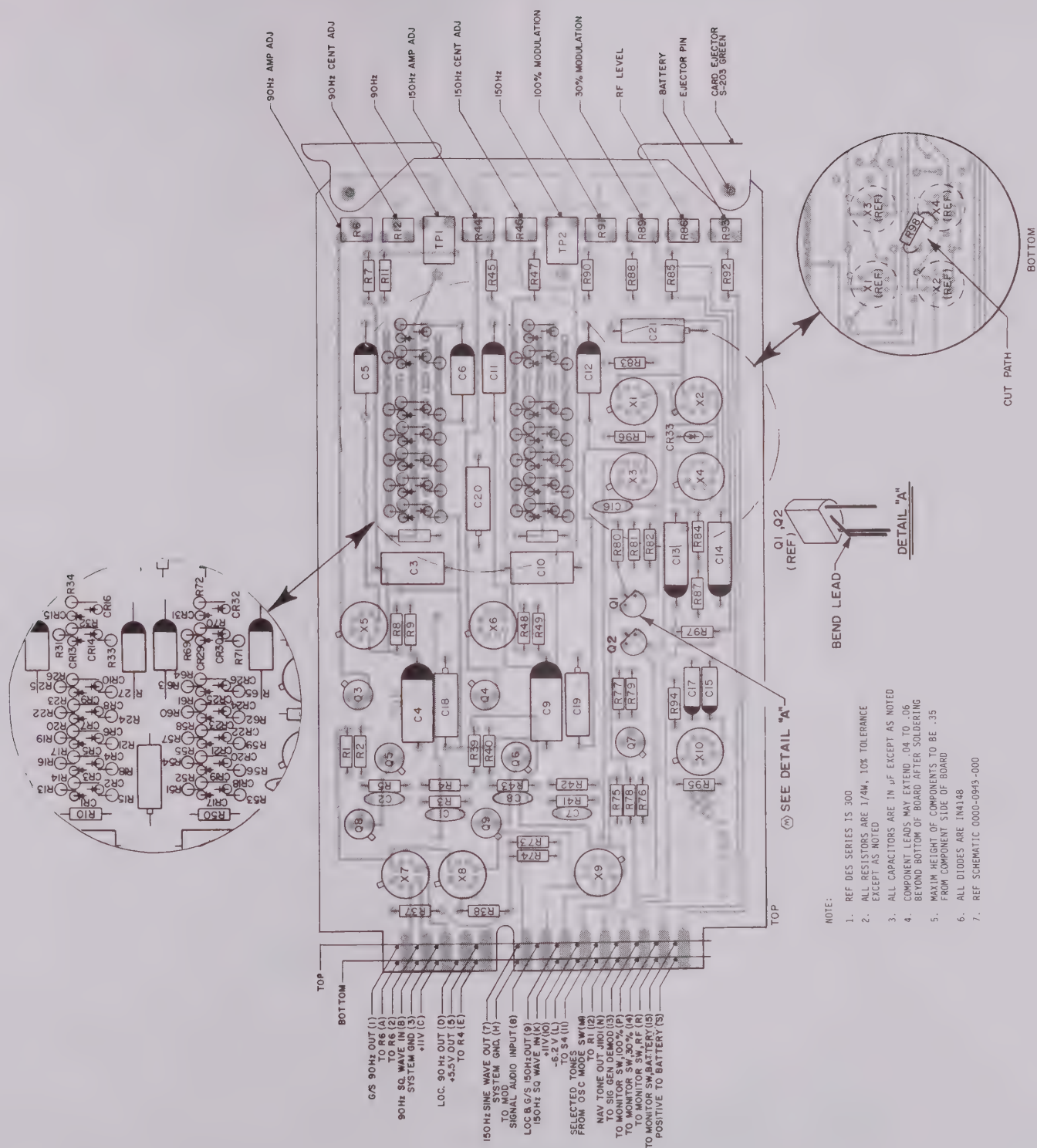


Figure 8-6 Combination Sine Board Parts Layout  
7010-0958-000 (R)



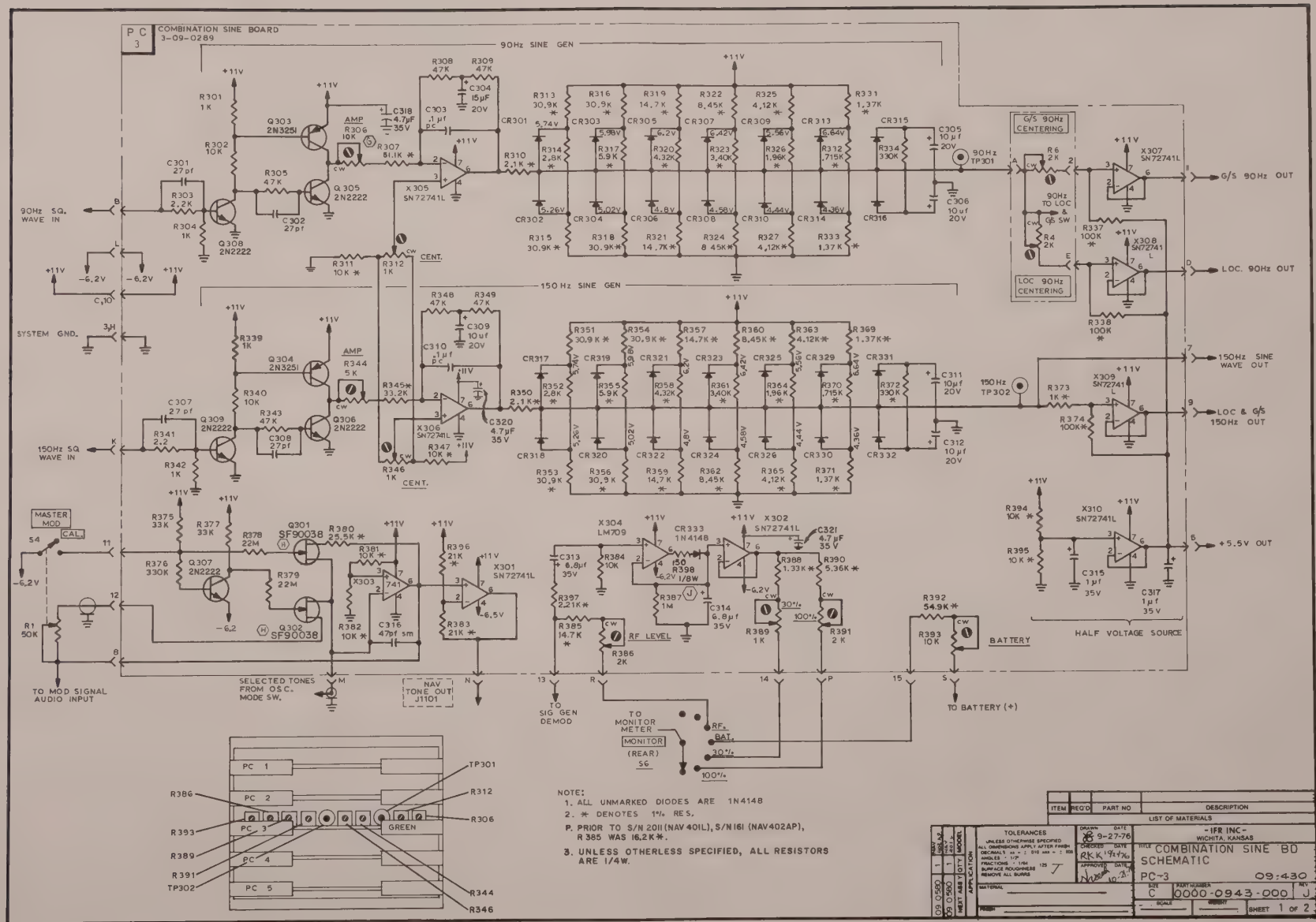
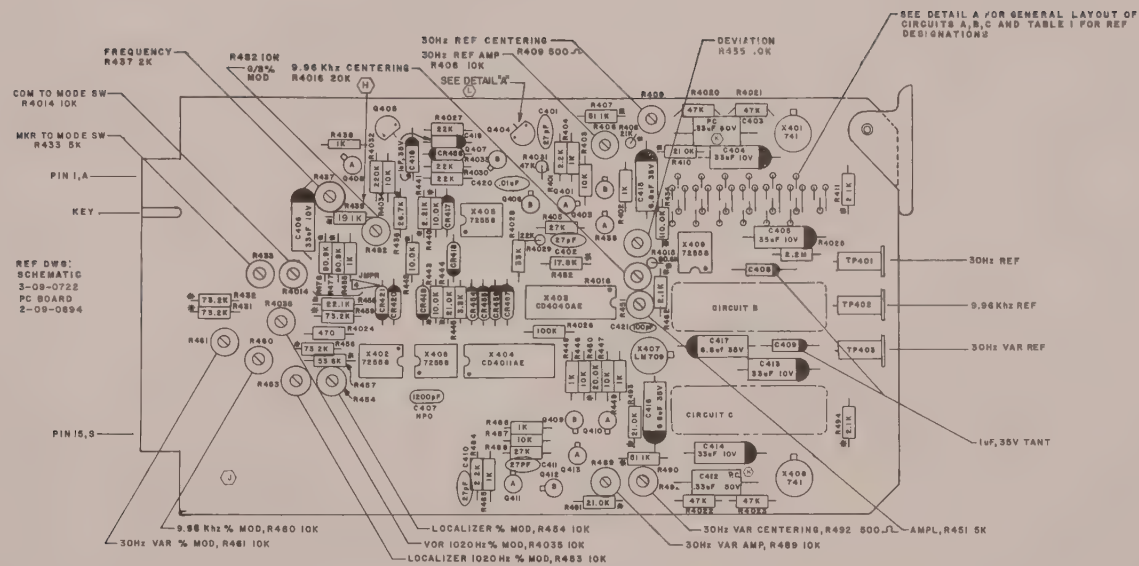
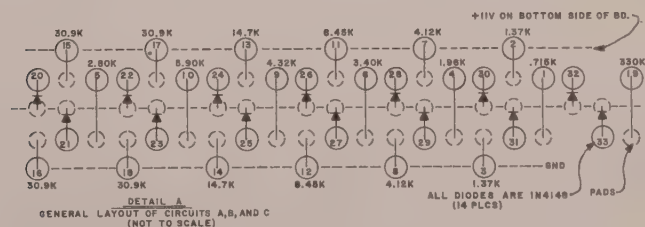


Figure 8-7





| TABLE 1 |                   |        |                   |
|---------|-------------------|--------|-------------------|
| PIN NO  | REF DESIG         | PIN NO | REF DESIG         |
| 2       | 6/5 DEV IN        | B      | 30Hz REF SINE OUT |
| 3       |                   | B      | 30Hz REF SINE OUT |
| 4       | 30Hz REF IN       | D      | 6/5 DEV OUT       |
| 5       |                   | E      | 6ND               |
| 6       | 9.96 KHz SINE OUT | F      | VOR TO MODE SW    |
| 7       | +8.8V             | J      | 9.96KHz IN        |
| 8       | 30Hz VAR OUT      | K      | MKR TO MODE SW    |
| 9       | COM TO MODE SW    | L      | MKR TO MODE SW    |
| 10      |                   | M      |                   |
| 11      |                   | N      | LOC XMTR          |
| 12      |                   | P      | LOC DEV IN        |
| 13      | LOC TO MODE SW    | R      |                   |
| 14      | +11V              | S      | 30Hz VAR IN       |
| 15      | 30Hz VAR POT (R2) |        |                   |



| TABLE 2 |        |           |           |
|---------|--------|-----------|-----------|
| NO.     | VALUE  | CIRCUIT A | CIRCUIT B |
| 1       | 715K   | R428      | R481      |
| 2       | 1.37K  | R427      | R479      |
| 3       | 1.37K  | R429      | R480      |
| 4       | 1.96K  | R425      | R475      |
| 5       | 2.80K  | R415      | R464      |
| 6       | 3.40K  | R422      | R472      |
| 7       | 4.12K  | R424      | R474      |
| 8       | 4.12K  | R426      | R476      |
| 9       | 4.32K  | R418      | R468      |
| 10      | 5.90K  | R416      | R466      |
| 11      | 8.45K  | R421      | R471      |
| 12      | 8.45K  | R423      | R473      |
| 13      | 14.7K  | R418      | R468      |
| 14      | 14.7K  | R420      | R470      |
| 15      | 30.9K  | R412      | R463      |
| 16      | 30.9K  | R414      | R465      |
| 17      | 30.9K  | R415      | R467      |
| 18      | 30.9K  | R417      | R469      |
| 19      | 330K   | R430      | R483      |
| 20      | 1N4148 | CR401     | CR422     |
| 21      |        | CR402     | CR423     |
| 22      |        | CR403     | CR424     |
| 23      |        | CR404     | CR425     |
| 24      |        | CR405     | CR426     |
| 25      |        | CR406     | CR427     |
| 26      |        | CR407     | CR428     |

|    |        |       |       |       |
|----|--------|-------|-------|-------|
| 33 | 1N4148 | CR414 | CR437 | CR453 |
| 32 |        | CR413 | CR436 | CR452 |
| 31 |        | CR412 | CR435 | CR451 |
| 30 |        | CR411 | CR434 | CR450 |
| 29 |        | CR410 | CR433 | CR449 |
| 28 |        | CR409 | CR432 | CR448 |
| 27 | 1N4148 | CR408 | CR431 | CR447 |
|    |        | CR407 | CR430 | CR446 |
|    |        | CR406 | CR429 | CR445 |

Figure 8-8 30 Hz Sine Board Parts Layout 7010-0970-800 (M)





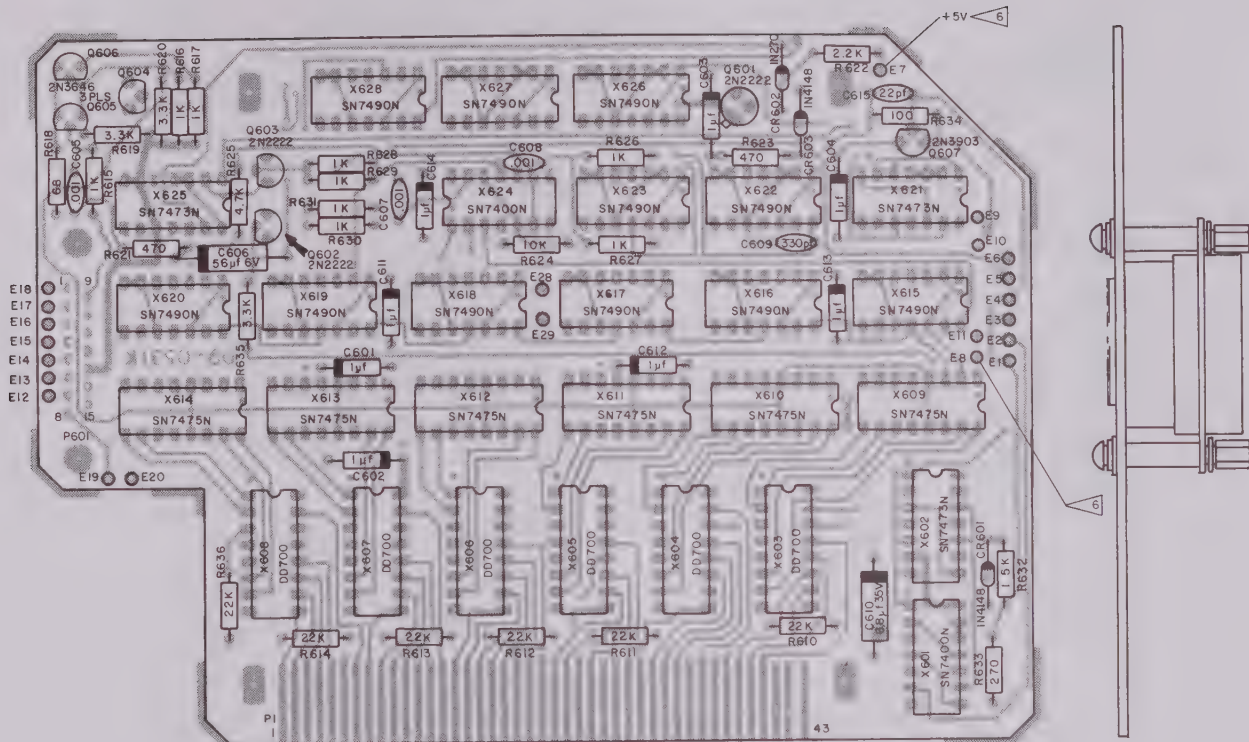






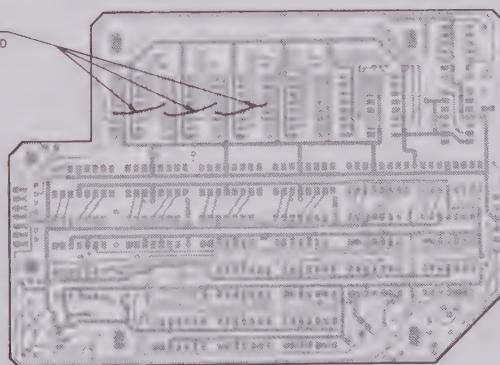






26 GA BUSS  
WIRE SLEEVED

7. MODIFICATIONS SHOWN ARE FOR "J" REV. BOS. ①
- ② TO R637 "TIME DELAY CONTROL" LOCATED ON FNT. PNL.
5. CHIP CAPACITORS ARE ON BACK OF BOARD UNLESS NOTED.
4. MAXIMUM HEIGHT OF COMPONENTS TO BE .35 FROM COMPONENT SIDE OF BOARD.
3. COMPONENT LEADS MAY EXTEND .04 TO .06 BEYOND BOTTOM OF BOARD AFTER SOLDERING.
2. ALL CAPACITORS ARE IN  $\mu$ F EXCEPT AS NOTED.
1. ALL RESISTORS ARE 1/4W, 10% TOL. EXCEPT AS NOTED.
- NOTES:



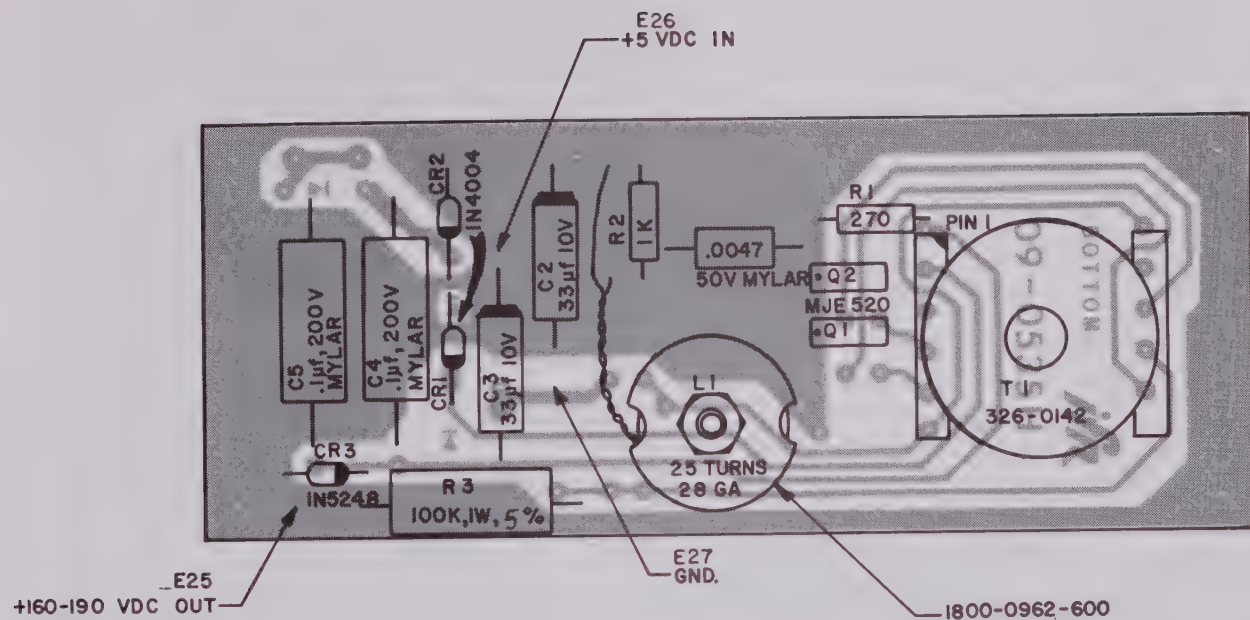
BOTTOM SIDE "J" REV. BOS.

Figure 8-12 Counter Board Parts Layout  
7010-0975-800 (J-1)









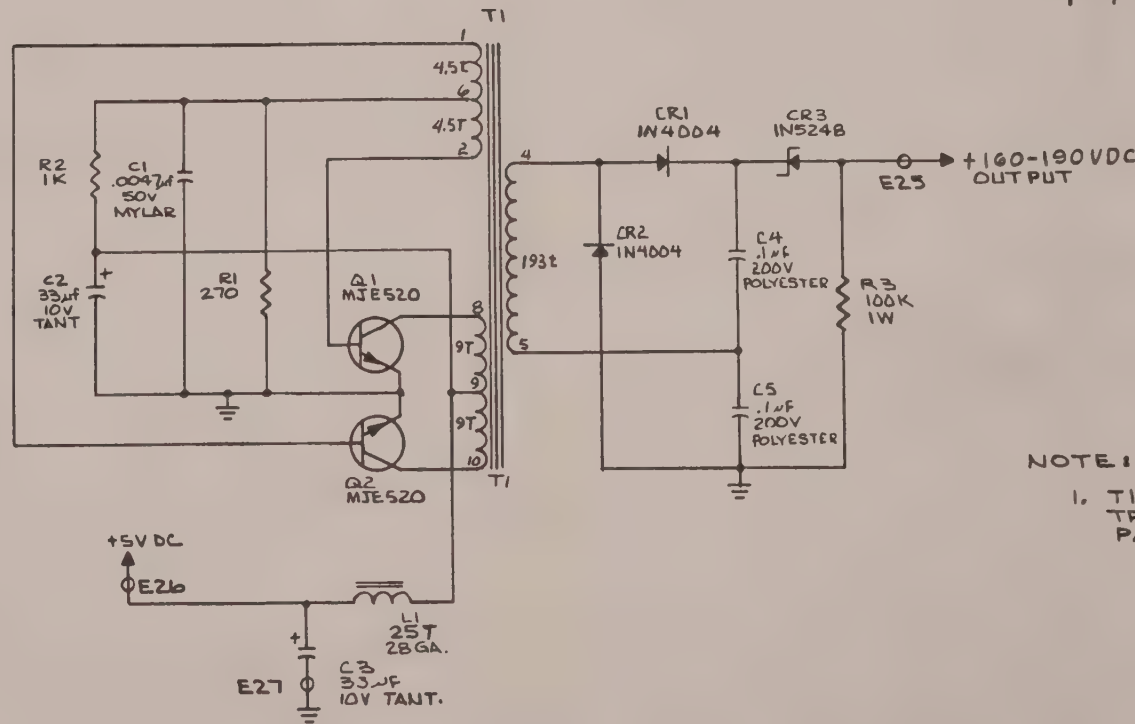
REF DWG.  
SCHEM. 2-09-560  
PC BD. 2-09-535

Figure 8-14 High Voltage Power Supply Board Parts Layout

7008-0972-100 (K)



| DATE     | REV | CHANGE                | APP'D |
|----------|-----|-----------------------|-------|
| 10-10-75 | B   | INCORP ECN # 1016 SSD | Ma    |
| 7-29-76  | C   | INC ECN # 1543 MO KKK | Ma    |
| 8-19-80  | D   | INC ECN # 3444 RLD    | C     |



NOTE:

1. T1 IS AN ALADDIN TRANSFORMER  
P/N 326-0142 REV. "A"

|                                                                                                                                                                             |     |          |                                                               |                                                                                                              |                              |           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|------------------------------|-----------|
| 09-0721                                                                                                                                                                     | 1   | NAV402AP |                                                               |                                                                                                              |                              |           |
| 09-0721                                                                                                                                                                     | 1   | NAV401L  | 1                                                             | 1                                                                                                            | 09-0560                      | SCHEMATIC |
| NEXT ASS'Y                                                                                                                                                                  | QTY | MODEL    | ITEM REQ'D                                                    | PART NO.                                                                                                     | DESCRIPTION                  |           |
| APPLICATION                                                                                                                                                                 |     |          | LIST OF MATERIALS                                             |                                                                                                              |                              |           |
| TOLERANCES<br>UNLESS OTHERWISE SPECIFIED<br>ALL DIMENSIONS APPLY AFTER FINISH<br>DECIMALS: .008<br>ANGLES: 1/8"<br>FRACTIONS: 1/64<br>SURFACE ROUGHNESS<br>REMOVE ALL BURRS |     |          | DRAWN<br>9-13-74<br>CHECKED<br>9-23-74<br>APPROVED<br>9-24-74 | INSTRUMENT FLIGHT RESEARCH CORPORATION<br>WICHITA, KANSAS<br>TITLE<br>HIGH VOLTAGE POWER<br>SUPPLY SCHEMATIC |                              |           |
| MATERIAL                                                                                                                                                                    |     |          | SIZE<br>B                                                     |                                                                                                              | PART NUMBER<br>0000-0956-000 |           |
| TREATMENT                                                                                                                                                                   |     |          | SCALE                                                         |                                                                                                              | WEIGHT                       |           |
| FINISH                                                                                                                                                                      |     |          |                                                               |                                                                                                              | SHEET 1 OF 1                 |           |

Fig. 8-15



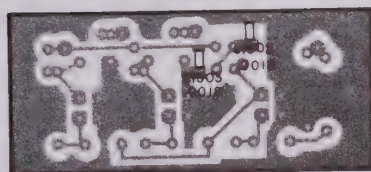
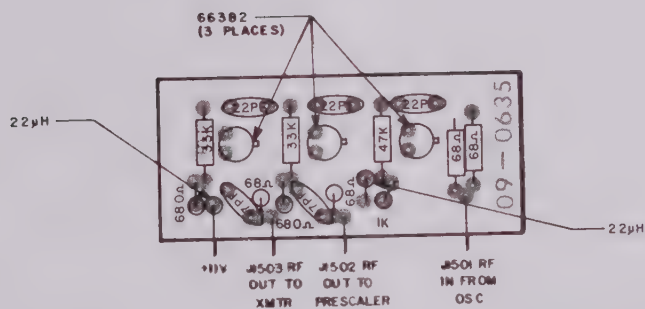
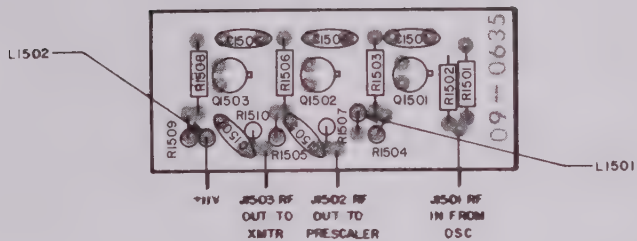
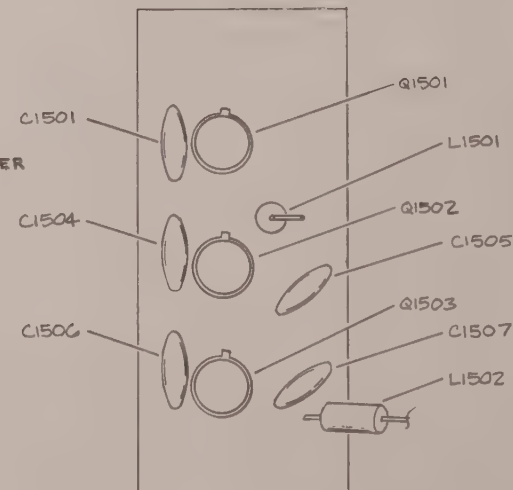
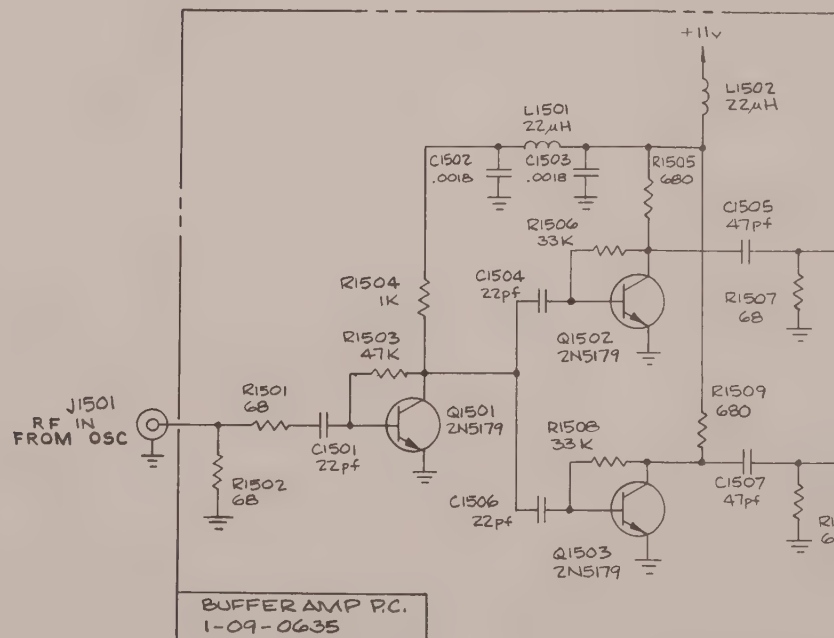


Fig. 8-16 BUFFER AMP BOARD PARTS LAYOUT

009-0779-014



| DATE | REV | CHANGE | APP'D |
|------|-----|--------|-------|
|      |     |        |       |



TOP VIEW OF P.C. BD.

NOTES:  
1. HIGHEST NUMBERS USED -  
C1507 L1502 Q1503 R1510

|                                                                                                                                                                                       |                       |                                                           |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------------------------------------------|------------|
| 09-0637                                                                                                                                                                               | NAV 401L<br>NAV 402AP | 09-0667                                                   | SCHEMATIC  |
| NEXT ASS'Y                                                                                                                                                                            | QTY                   | MODEL                                                     | ITEM REQ'D |
| APPLICATION                                                                                                                                                                           |                       | LIST OF MATERIALS                                         |            |
| TOLERANCES<br>UNLESS OTHERWISE SPECIFIED<br>ALL DIMENSIONS APPLY AFTER FINISH<br>DECIMALS: 2 .005<br>ANGLES: 2 1/2°<br>FRACTIONS: 2 1/64<br>SURFACE ROUGHNESS 125<br>REMOVE ALL BURRS |                       | INSTRUMENT FLIGHT RESEARCH CORPORATION<br>WICHITA, KANSAS |            |
| MATERIAL P/LIST 1-09-0634                                                                                                                                                             |                       | TITLE<br>BUFFER AMP<br>SCHEMATIC<br>NAV-401L NAV-402AP    |            |
| TREATMENT                                                                                                                                                                             |                       | PART NUMBER<br>2-09-0667                                  |            |
| FINISH                                                                                                                                                                                |                       | SCALE WEIGHT                                              |            |
| SHEET 1 OF 1                                                                                                                                                                          |                       |                                                           |            |

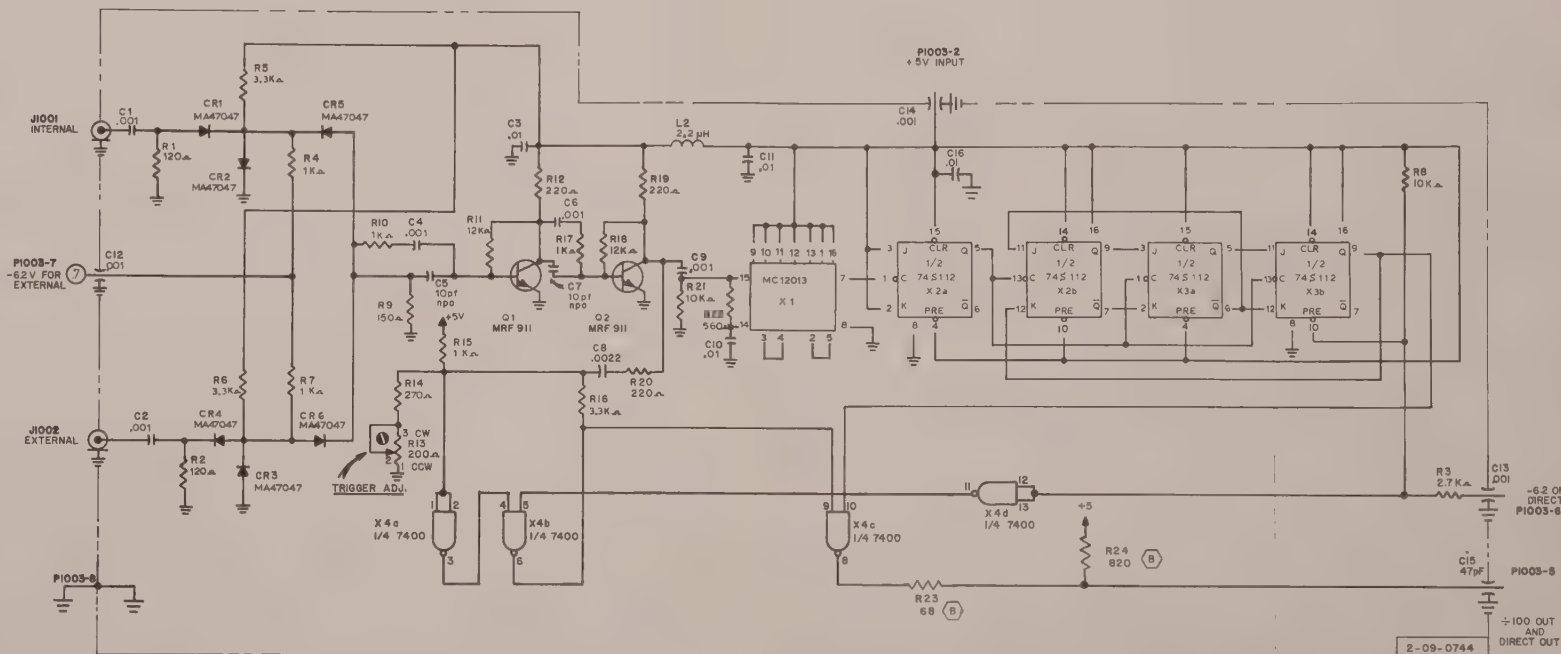
Fig. 8-17







| REV | DATE    | CHANGE         | APP'D |
|-----|---------|----------------|-------|
| A   | 5-14-79 | ECN # 3328 RLD | TE    |
| B   | 12-8-84 | ECN 6513       | TE    |



3. LAST USED NO'S: X4

L2

Q2

CR6

C16

R22

2. ALL CAPACITOR VALUES ARE IN pF EXCEPT AS NOTED.

1. ALL RESISTORS ARE 1/4W, 10% TOLERANCE

NOTES:

|                                             |     |
|---------------------------------------------|-----|
| 3-09-0743 PRESCALER SCHEMATIC               |     |
| ITEM                                        | REV |
| LIST OF MATERIALS                           |     |
| DESCRIPTION                                 |     |
| TOLERANCES                                  |     |
| UNLESS OTHERWISE SPECIFIED                  |     |
| ALL DIMENSIONS ARE IN INCHES                |     |
| DIMENSIONS IN PARETHESES ARE IN MILLIMETERS |     |
| ANGLES - 1/8"                               |     |
| SURFACE FINISHES                            |     |
| REMOVE ALL BURRS                            |     |
| DATE                                        |     |
| BY                                          |     |
| CHECKED                                     |     |
| APPROVED                                    |     |
| TITLE                                       |     |
| PRESCALER SCHEMATIC                         |     |
| PART NUMBER                                 |     |
| C 0974-300                                  |     |
| SHEET 1 OF 1                                |     |

Figure 8-20 Prescaler Schematic



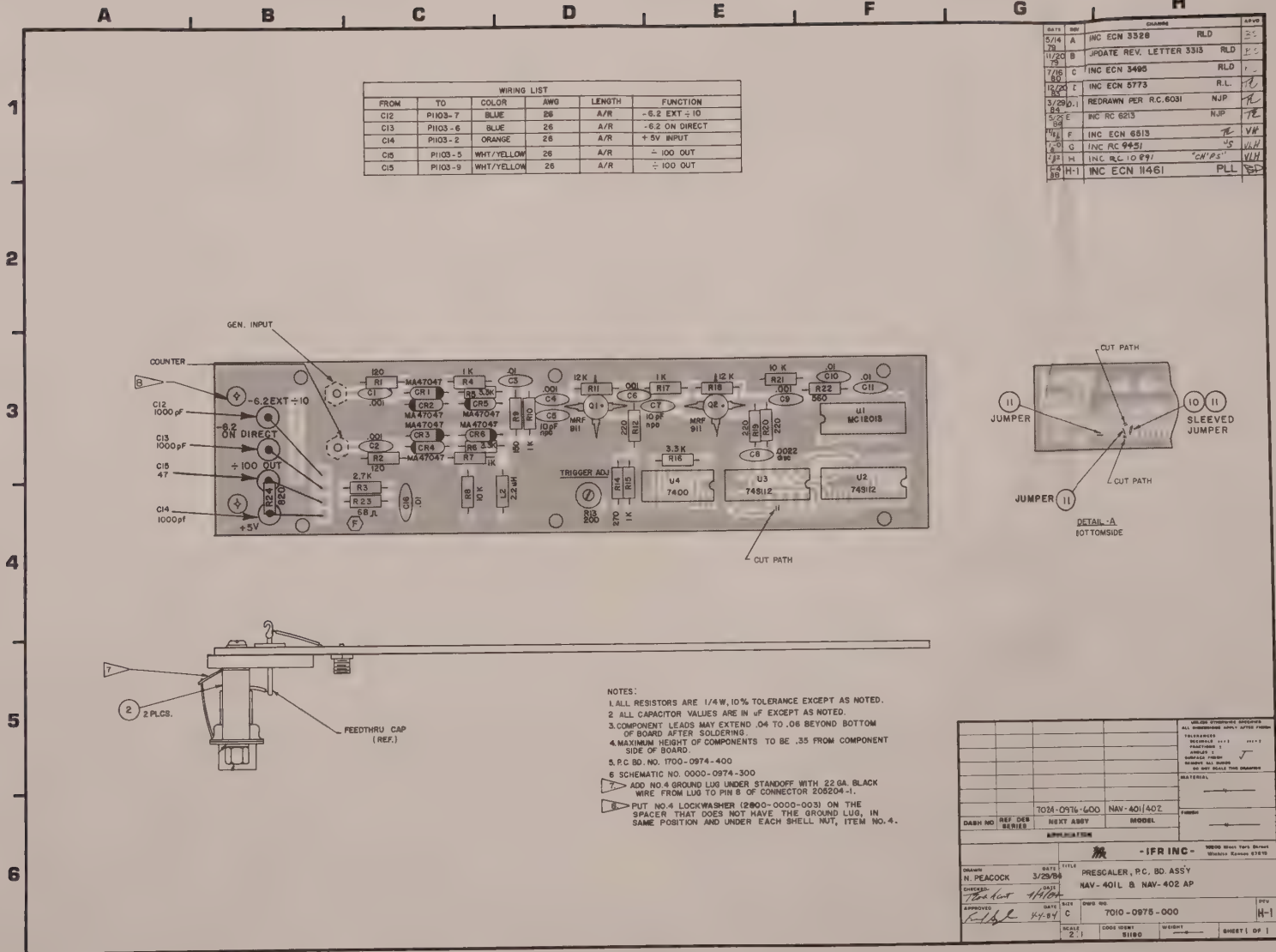
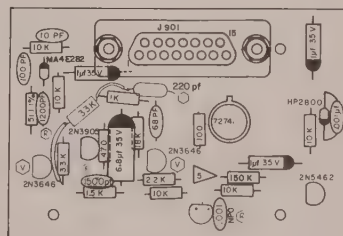
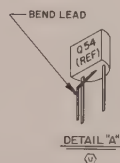
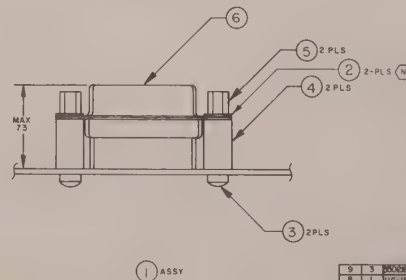
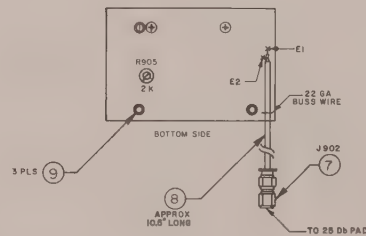
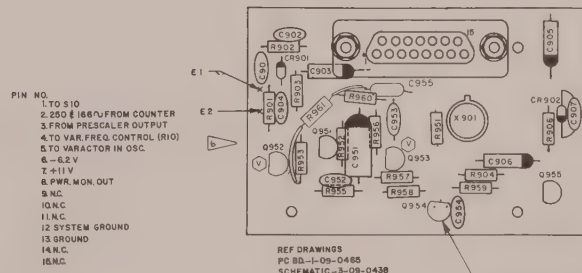


Figure 8-19 Prescaler Board Parts Layout



| DATE    | REV | CHANGE                    | APP |
|---------|-----|---------------------------|-----|
| 0-0-00  | IL  | ORIGINAL RELEASE          |     |
| 0-7-79  | J   | INC ECM 5271 WLD          |     |
| 0-5-79  | K   | UPDATED RECD TO 3300      |     |
| 0-8-81  | L   | INC ECM 5438              |     |
| 0-7-82  | M   | INC ECM 5754              |     |
| 0-8-83  | N   | (ITEM 2) OTY FROM 4 TO 2. |     |
| 0-8-83  | N   | INC RCN 5739              |     |
| 0-10-84 | K   | INC EC 8117               | DAH |
| 0-8-84  | T   | INC RC 9407               | AO  |
| 0-8-84  | U   | INC ECM 9456              |     |
| 0-21-87 | V   | INC RC 10312              |     |



- (N)  SLEEVE LEADS OF R961  
 (N)  PRIOR TO SN2099 WAS 330 K  
 4. MAXIMUM HEIGHT OF COMPONENTS TO BE .35 FROM COMPONENT SIDE OF BOARD.  
 3. COMPONENT LEADS MAY EXTEND .04 TO .06 BEYOND BOTTOM OF BOARD AFTER SOLDERING.  
 2. ALL CAPACITORS ARE IN  $\mu$ F EXCEPT AS NOTED.  
 1. ALL RESISTORS ARE 1/4W, 10% TOL. EXCEPT AS NOTED
- NOTES

[illegible]

Fig. 8-21













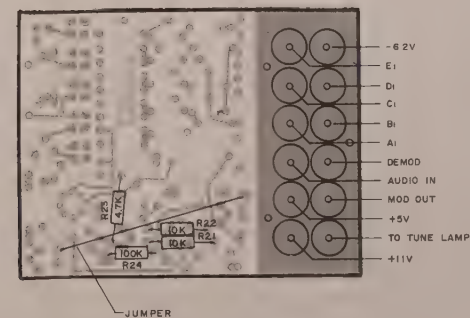
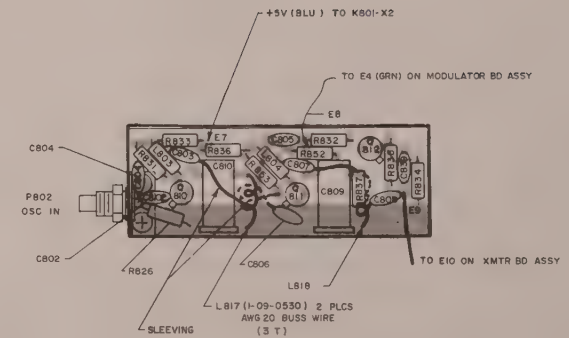
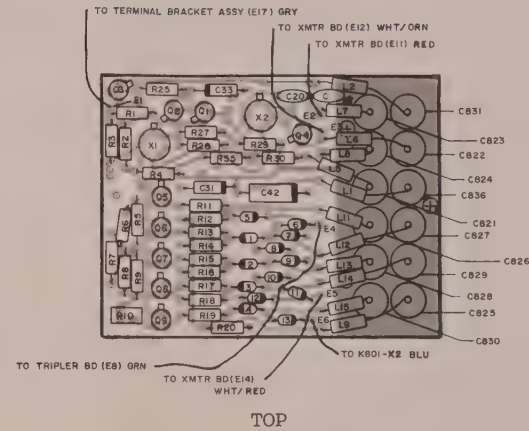
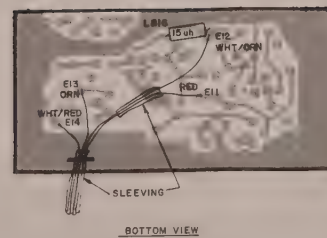
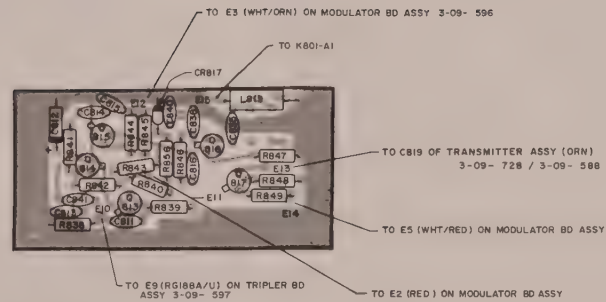
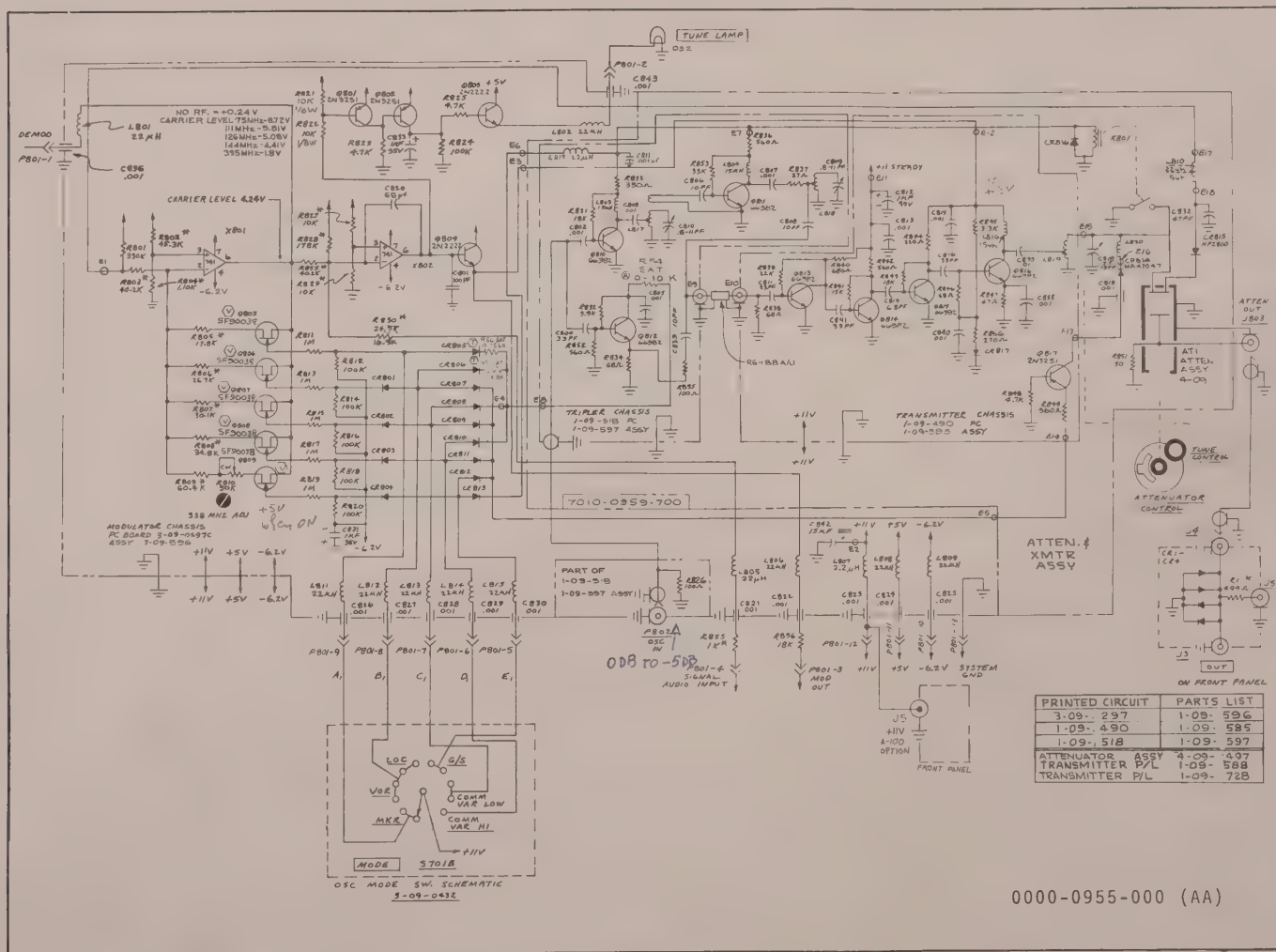


Fig. 8-25 TRANSMITTER, MODULATOR & TRIPLER BOARDS PARTS LAYOUTS



#### NOTES:

1. All upward arrows unless otherwise specified go to +11V.
2. All Diodes are 1N4148 unless otherwise shown.
3. Effective S/N 1690 XTERS 2N3415 replaced by 2N2222, XTERS 2N5366 by 2N3251
4. Prior to S/N 1819 CR814 was PS0-83B
5. Prior to S/N 1841 XSTR Q810 was 2N5179 Resistor R833 was 270 ohms.
6. XTERS 2N3251 replaced by 2N2907A unless otherwise shown.
7. Voltage at junction of R802 and R803 should be +0.261V

Figure 8-26 Modulator, PA and Attenuator Schematic



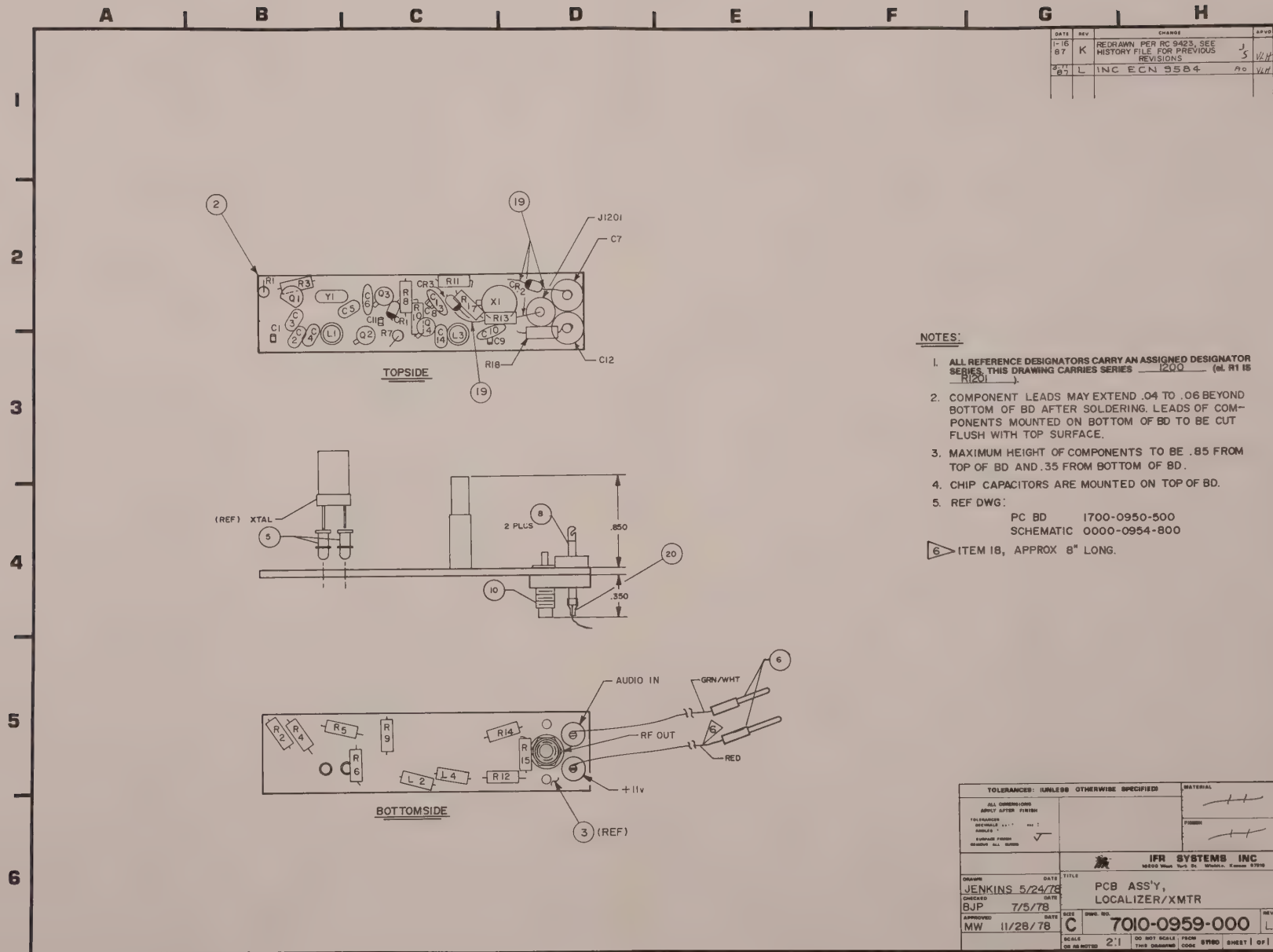
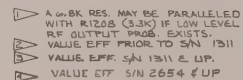


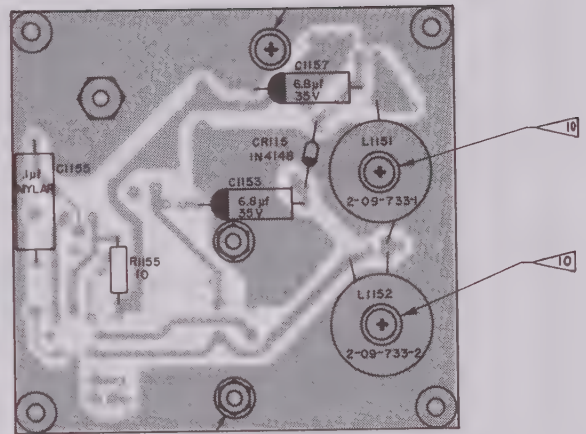
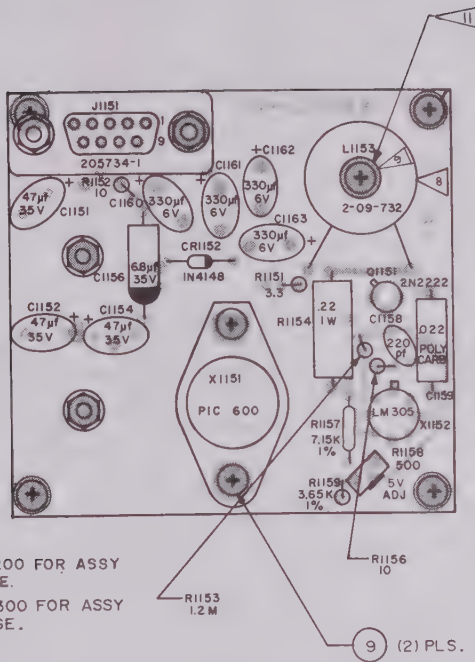
Fig. 8-27



[illegible]

8-53/8-54 Blank  
08





REF DWG 1800-0973-200 FOR ASSY AND HARDWARE USAGE.  
REF DWG 1800-0973-300 FOR ASSY AND HARDWARE USAGE.

TOP

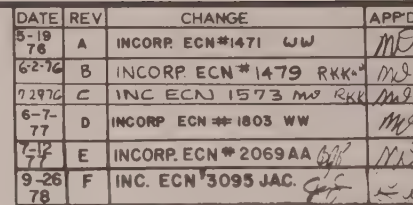
BOTTOM

7. PRIOR TO S/N: 865 (ATC 600), 1930 (NAV 401L), 158 (NAV 402 AP), R1155 WAS 15 Ω.
6. PRIOR TO S/N: 781 (ATC 600), 1819 (NAV 401L), 137 (NAV 402 AP); L1153 WAS 40 TURN.
5. EFFECTIVE S/N: 621 (ATC 600), 1636 (NAV 401L), 132 (NAV 402 AP).
4. MAXIMUM HEIGHT OF COMPONENTS TO BE .35 FROM COMPONENT SIDE OF BOARD.
3. COMPONENT LEADS MAY EXTEND .04 TO .06 BEYOND BOTTOM OF BOARD AFTER SOLDERING.
2. ALL CAPACITORS ARE IN µf EXCEPT AS NOTED.
1. ALL RESISTORS ARE 1/4W, 10% TOL. EXCEPT AS NOTED.

REF. DRAWING, SCHEMATIC: 0000-0972-900

Figure 8-29 5 Volt Regulator Parts Layout  
7023-0973-100 (Y)





(P/LIST 1-09-0731)

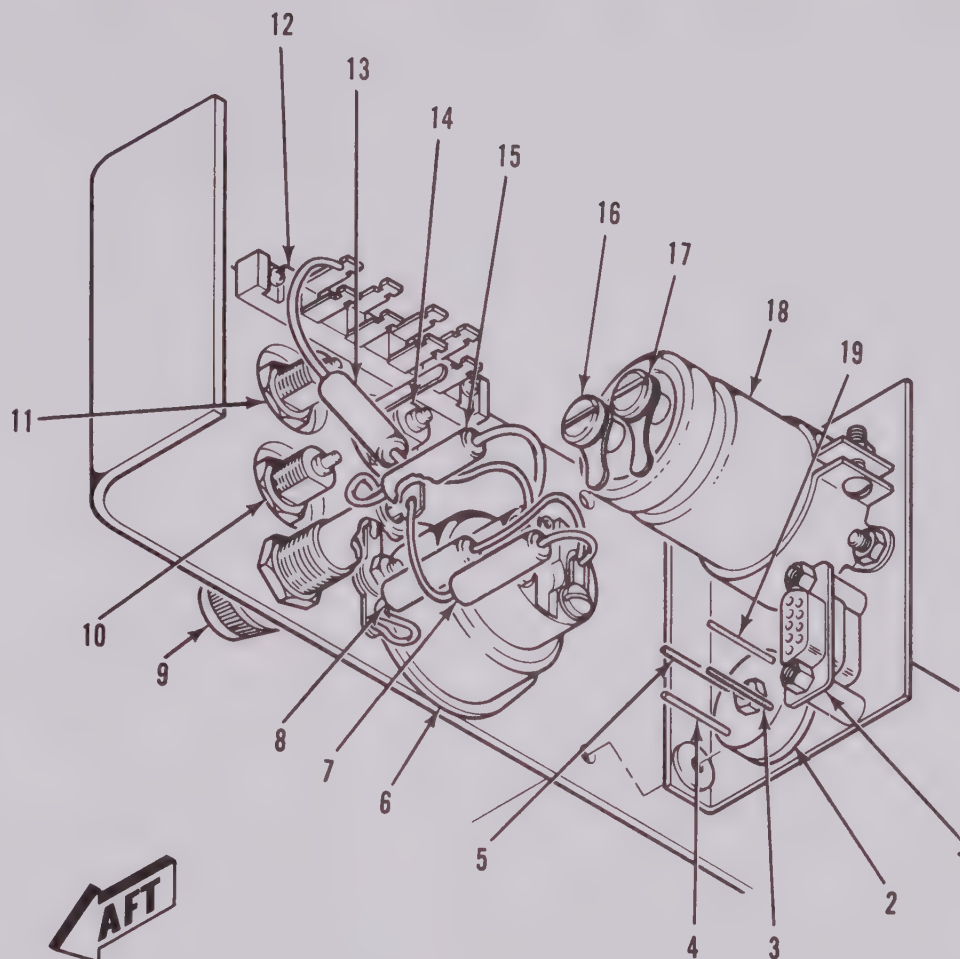


1. RES. ARE IN  $\Omega$
2. LAST No.s USED: L1153, X1152, Q1151, C1163, & R1159.
3. EFFECTIVE S/N: 621 (ATC 600)  
1636 (NAV 401L)  
132 (NAV 402AP)
4. PRIOR TO S/N: 781(ATC 600), 1819(NAV 401L),  
137(NAV 402AP); L1153 WAS 40 TURN.
5. PRIOR TO S/N: 865 (ATC 600), 1930 (NAV 401L),  
158(NAV 402AP), R1155 WAS 15 $\Omega$ .

|                                                                         |                                     |                                                                                               |                      |
|-------------------------------------------------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------|----------------------|
| INSTRUMENT FLIGHT<br>RESEARCH CORP.<br>4053 Navajo Lane<br>Wichita, Ks. |                                     | DWN<br>  | DATE<br>11-14-75     |
| 5V REGULATOR<br>SCHEMATIC<br>(ASSY 4)                                   |                                     | CHKD<br> | DATE<br>11-14-75     |
|                                                                         |                                     | APP<br>A.                                                                                     | DATE<br>11-14-75     |
| PART NO<br>2-09-0729                                                    |                                     | REV F<br>DATES 9-26-78                                                                        | DWN W.W.<br>APP W.W. |
| SCALE                                                                   | MODEL NAV 402AP<br>ATC 600/NAV 401L | SNT. 1 of 1                                                                                   |                      |

Fig. 8-30

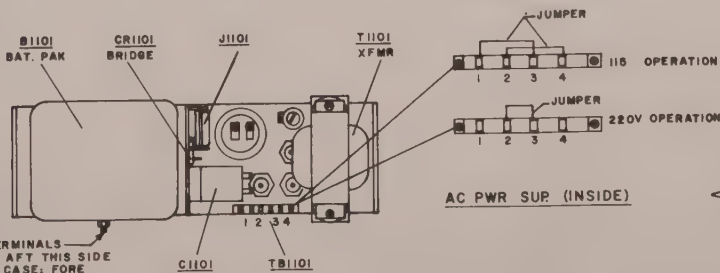
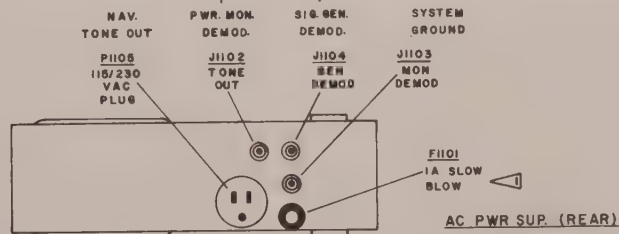
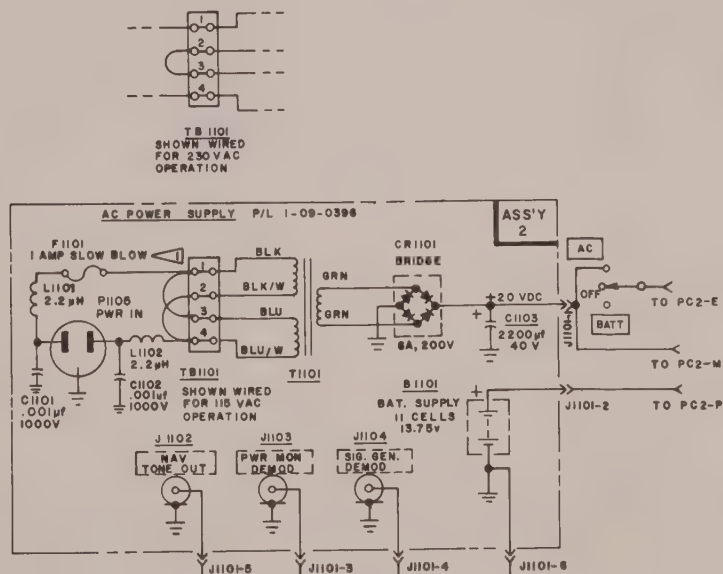




|                         |            |                          |
|-------------------------|------------|--------------------------|
| 1. J1101                | 8. C1110   | 14. J1102                |
| 2. CR1101               | 9. F1101   | 15. C1102                |
| 3. Positive Term. +20 V | 10. J1103  | 16. Negative Term. -Gnd. |
| 4. AC Input Term.       | 11. J1104  | 17. Positive Term. +20 V |
| 5. Negative Term. -Gnd. | 12. TB1101 | 18. C1103                |
| 6. P1105                | 13. L1102  | 19. AC Input Term.       |
| 7. L1101                |            |                          |

Fig. 8-31 AC POWER SUPPLY PARTS LAYOUT





TWO TERMINALS  
FORE & AFT THIS SIDE  
OF BAT. CASE; FORE  
IS + (POS)

1 AMP FUSE FOR 115V. 1/2 AMP FUSE FOR 220V.

| ITEM              |  | REQ'D | PART NO | DESCRIPTION               |
|-------------------|--|-------|---------|---------------------------|
| 3-09-0748         |  |       |         | AC POWER SUPPLY SCHEMATIC |
| LIST OF MATERIALS |  |       |         |                           |
| - IFR INC -       |  |       |         |                           |
| WICHITA, KANSAS   |  |       |         |                           |
| AC POWER SUPPLY   |  |       |         |                           |
| SCHEMATIC         |  |       |         |                           |
| ASS'Y 2           |  |       |         |                           |
| 3-09-0748         |  |       |         |                           |
| SCALE 1:1         |  |       |         |                           |
| SHEET 1 OF 1      |  |       |         |                           |



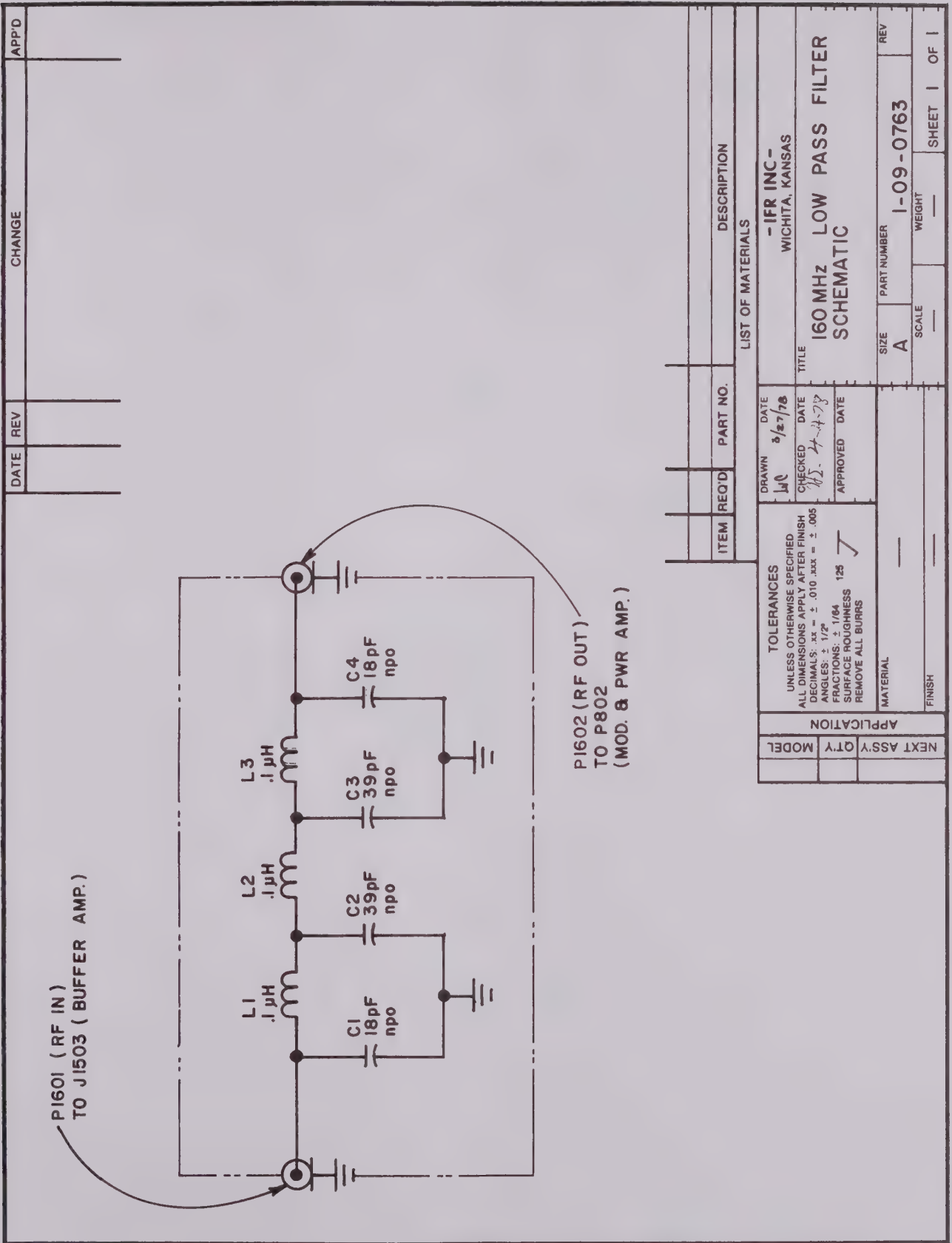
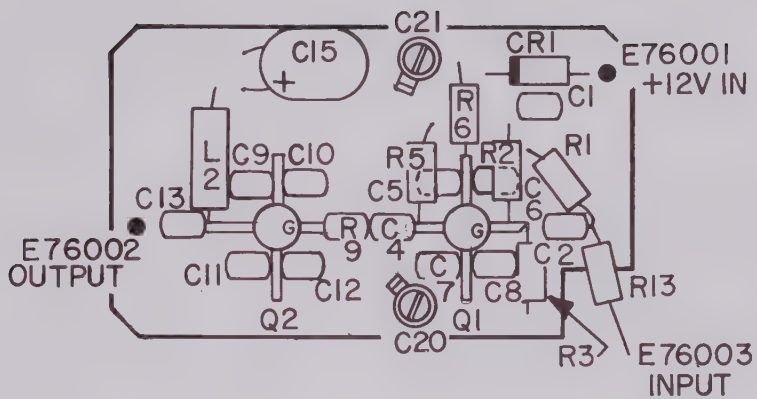
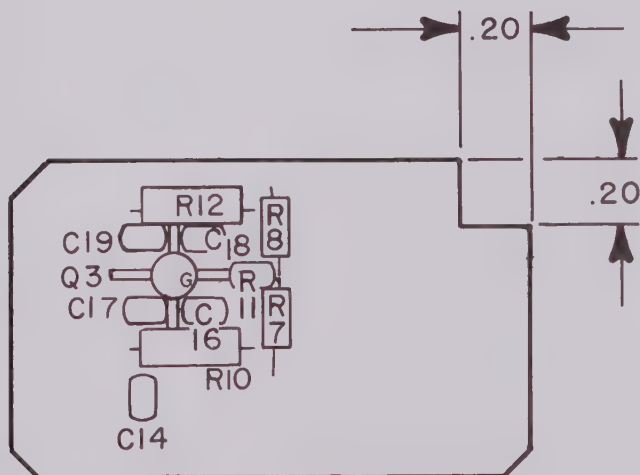


Fig. 8-33





TOP



BOTTOM

Fig. 8-34 +20 dB EXTERNAL AMP PC BOARD



## PARTS LIST

### NAV-401L/402AP SECTION 9

9-1 Introduction.

9-2 The parts list included in this section is a listing primarily of active components and those components which may require replacement. Other mechanical parts are listed on the mechanical assembly drawings of Section 8 and Section 10. Unless otherwise indicated the parts listed herein are used in all NAV-401L test sets S/N 1639 and on. Effectivities for each assembly or group of components are indicated at the beginning of each listing, where necessary.



---

NAV-401L PARTS LIST

---

## 9-3 Front Panel Assembly

| Dwg/Ref<br>Symbol | Part<br>No.             | IFR<br>Stock No. | Description                                                                | Qty Per<br>Assy |
|-------------------|-------------------------|------------------|----------------------------------------------------------------------------|-----------------|
|                   | 7004-0959-300           | 7004-0959-301    | Front Panel Assy                                                           | REF             |
| S-2               | 1-76-009                |                  | Bearing Switch Assy.                                                       | 1               |
|                   | 177606MV                |                  | Switch, EECO/Equiv.                                                        | 4               |
| M1                | 112HL                   | 2-76-004         | Power Meter, INTER-<br>NATIONAL INST/Equiv.                                | 1               |
| S-3               | CK7101                  | 5114-0000-001    | Switch, C&K/Equiv.                                                         | 1               |
| S-1               | CK7027J103              |                  | Switch, C&K/Equiv                                                          | 1               |
| L-1 &<br>L-2      | BEP                     | 3901-0000-003    | Lamp base, SHELLY/<br>Equiv                                                | 2               |
| L-1 &<br>L-2      | RBP                     | 3900-0000-001    | Lens, SHELLY/Equiv.                                                        | 2               |
|                   | #229                    |                  | Lamp, GE/Equiv                                                             | 2               |
| S11               | 46-101R                 | 5115-0000-004    | Switch, GRAYHILL/<br>Equiv.                                                | 1               |
| R5 &<br>R7        | RV6NAYSD-<br>253A       | 4750-7600-300    | 25K Pot, CLAROSTAT/<br>Equiv.                                              | 2               |
| R4, R6, &<br>R8   | RV6LAYS-<br>A252A       | 4751-0252-001    | 2.5K Pot, CLAROSTAT/<br>Equiv.                                             | 3               |
| R9, R10<br>& S12  |                         | 1-76-059         | Main & Fine Freq.<br>Var & SW. Assy.<br>(Eff: to S/N2569)                  | 1               |
| R9                |                         | 1-76-058         | 10K, 10 Turn Pot,<br>ELECTROTECH/Equiv.                                    | 1               |
| R10 &<br>S12      | CM39005                 | 1-76-060         | 100 $\Omega$ , Modified Pot<br>W Switch, CLAROSTAT/<br>Equiv.              | 1               |
| R9, R10 &<br>S12  | 86A3DG36-<br>J15A05/R55 | 1-76-059-1       | Main & Fine Freq. Var<br>& Sw. Assy. BOURNS/<br>Equiv. (Eff: S/N2569 & on) | 1               |
| J1 & J2           | UG-1094/U               | 2113-0000-018    | Connector, AMPHENOL/<br>Equiv.                                             | 2               |

---

NAV-401L PARTS LIST

---

## 9-3 Front Panel Assy. (cont.)

| Dwg/Ref<br>Symbol | Part<br>No.         | IFR<br>Stock No. | Description                                                                              | Qty Per<br>Assy |
|-------------------|---------------------|------------------|------------------------------------------------------------------------------------------|-----------------|
| S-5 &<br>S-8      | 71BD36-<br>02-1-AJN | 5111-0000-012    | Switch, 10 position<br>GRAYHILL/Equiv (Inter-<br>changeable with P/N<br>39727-1210-SM-2) | 2               |
| R1                | 39033               | 4750-7601-700    | 50 K Pot, CLAROSTAT/<br>Equiv.                                                           | 1               |
| R2 &<br>R3        | 39032               | 4750-7601-800    | 100 K Dual Pot, CLARO-<br>STAT/Equiv.                                                    | 1               |
| S-10              | CK7201              | 5114-0000-004    | Switch, C & K/Equiv.                                                                     | 1               |
|                   |                     | 1-09-400         | Inner Round Knob for<br>Variable 30 Hz Control                                           | 1               |
|                   |                     | 1-09-401         | Outer Round Knob for<br>Variable 9960 Hz<br>Control                                      | 1               |
|                   |                     | 1-00-056-1       | Bar Knob for Monitor<br>Meter Function, Fre-<br>quency Mode and Tone<br>Select Switches  | 3               |
|                   |                     | 1-00-056-2       | Bar Knob for Localizer<br>DDM, Glide Slope DDM and<br>Counter Mode Switches              | 3               |
|                   |                     | 1-00-57-1        | Round Knob for Local-<br>izer Variable DDM and<br>Glide Slope Variable DDM<br>Controls   | 2               |
|                   |                     | 1-09-219         | Outer Round Knob for<br>Variable Frequency<br>Control                                    | 1               |
|                   |                     | 1-09-220         | Inner Round Knob for<br>Variable Frequency<br>Control                                    | 1               |
| S-701             | PS107               | 1-76-006         | Switch, CENTRALAB/<br>Equiv                                                              | 1               |
| S-6               | 51CD30-             | 5111-0000-0013   | Switch GRAYHILL/<br>Equiv.                                                               | 1               |

---

NAV-401L PARTS LIST

---

9-3 Front Panel Assy (cont.)

| Dwg/Ref<br>Symbol | Part<br>No.          | IFR<br>Stock No. | Description                                    | Qty Per<br>Assy |
|-------------------|----------------------|------------------|------------------------------------------------|-----------------|
| S-7               | 51CD30-<br>01-2-ADJN | 5111-0000-014    | Switch, GRAYHILL/Equiv.                        | 1               |
| S-9               | 39-1                 | 5115-0000-002    | Momentary Switch, GRAY-<br>HILL/Equiv.         | 1               |
|                   |                      | 1-09-716         | Counter Assembly                               | 1               |
|                   |                      | 1-09-379         | Dual Knob Assembly                             | 1               |
|                   |                      | 1-09-386         | Dial Assy, Attenuator                          | 1               |
|                   |                      | 1-09-559         | Bezel (Interchange-<br>able with P/N 1-09-551) | 1               |
|                   |                      | 1-09-256         | Lens (Interchange-<br>able with P/N 1-09-551)  | 1               |
|                   |                      | 1-00-097         | Round Knob for<br>Attenuator                   | 1               |



---

NAV-401L PARTS LIST

---

9-4 Digital Counter Assy.

| Dwg/Ref<br>Symbol | Part<br>No.               | IFR<br>Stock No. | Description                                | Qty<br>Per<br>Assy |
|-------------------|---------------------------|------------------|--------------------------------------------|--------------------|
|                   |                           | 1-09-716         | Digital Counter Assy.                      | REF                |
|                   |                           | 1-09-758         | • Counter Board Assy.                      | 1                  |
|                   |                           | 1-09-757         | • Display Board Assy.                      | 1                  |
| R637              | RV6NAY-<br>5D104A         |                  | • 100 K Potentiometer,<br>CLAROSTAT/Equiv. | 1                  |
| S-601             | 39137-<br>1212SM-<br>3-PB |                  | • Switch, GRIGSBY/Equiv.                   | 1                  |
|                   |                           | 1-09-271         | • HV Power Supply Assy.                    | 1                  |



---

NAV-401L PARTS LIST

---

9-5 Counter Board Assy.

| Dwg/Ref<br>Symbol                                 | Part<br>No.                            | IFR<br>Stock No. | Description                                                         | Qty<br>Per<br>Assy. |
|---------------------------------------------------|----------------------------------------|------------------|---------------------------------------------------------------------|---------------------|
|                                                   |                                        | 3-09-758         | Counter Board Assy.                                                 | REF                 |
| X603-<br>608                                      | DD-700                                 |                  | • BECKMAN/Equiv, Logic<br>(Interchangeable with<br>NATIONAL DM8880) | 6                   |
| X601,<br>624                                      | 7400                                   |                  | • TI/Equiv, Logic                                                   | 2                   |
| X602,<br>621 &<br>625                             | 7473                                   |                  | • TI/Equiv, Logic                                                   | 3                   |
| X609 -<br>614                                     | 7475                                   |                  | • TI/Equiv, Logic                                                   | 6                   |
| X615 -<br>620, 622,<br>623, 626,<br>627, &<br>628 | 7490                                   |                  | • TI/Equiv, Logic                                                   | 11                  |
| CR602                                             | 1N270                                  |                  | • Diode, SOLID STATE/<br>Equiv.                                     | 1                   |
| CR601,<br>603, 604                                | 1N4148                                 |                  | • Diode, SOLID STATE/<br>Equiv.                                     | 3                   |
| Q607                                              | 2N3646<br>(EFF:<br>S/N 1690 -<br>1718) |                  | • Transistor, NATIONAL/<br>Equiv.                                   | 1                   |
|                                                   | 2N3903<br>(EFF:<br>S/N 1718<br>& ON)   |                  | • Transistor, NATIONAL/<br>Equiv.                                   |                     |
| Q604-606                                          | 2N3646                                 |                  | • Transistor, NATIONAL/<br>Equiv.                                   | 3                   |
| Q601-603                                          | 2N2222                                 |                  | • Transistor, SOLID<br>STATE/Equiv.                                 | 3                   |
|                                                   |                                        | 1-09-757         | • Display PC Board Assy                                             | 1                   |
| DS1-DS3                                           | SP-332                                 |                  | • 7 Segment Display,<br>BECKMAN/Equiv.                              | 3                   |



NAV-401L/402AP PARTS LIST

9-6 High Voltage Power Supply

| Dwg/Ref<br>Symbol | Part<br>No. | IFR<br>Stock No. | Description                        | Qty<br>Per<br>Assy. |
|-------------------|-------------|------------------|------------------------------------|---------------------|
| 2-09-721          |             | 1-09-721         | High Voltage Power<br>Supply Assy. | REF                 |
| T-1               | 326-0142    |                  | • Transformer, ALLADIN/<br>Equiv.  | 1                   |
| CR1 & 2           | 1N4004      |                  | • Diode, TI/Equiv.                 | 2                   |
| CR3               | 1N5248      |                  | • Zener Diode, MOTOROLA/<br>Equiv. | 1                   |
| Q1 & 2            | MJE 520     |                  | • Transistor, MOTOROLA/<br>Equiv.  | 2                   |



---

NAV-401L PARTS LIST

---

9-7 Power Supply Assy.

| Dwg/Ref<br>Symbol          | Part<br>No.         | IFR<br>Stock No. | Description                                                                                     | Qty<br>Per<br>Assy |
|----------------------------|---------------------|------------------|-------------------------------------------------------------------------------------------------|--------------------|
| 3-09-408<br>or<br>4-08-064 |                     | 1-08-064         | Power Supply Assy.                                                                              | REF                |
|                            |                     | 3-09-338         | • Power Supply Chassis                                                                          | 1                  |
| T1101                      | NT859               | 1-00-077B        | • Transformer, NATIONAL/<br>Equiv.                                                              | 1                  |
|                            | HKP                 |                  | • Fuse Holder, BUSSMAN/<br>Equiv.                                                               | 1                  |
| F1101                      | MDL-1               |                  | • •Fuse, 1A Slow Blow;<br>BUSS/Equiv.                                                           | 1                  |
| J1102,<br>1103 &<br>1104   | UG-1094/U           |                  | • Connector, AMPHENOL/<br>Equiv.                                                                | 3                  |
| J1101                      | 205203-1            |                  | • •Connector, AMP/Equiv.                                                                        | 1                  |
| CR1101                     | PK-10               |                  | • Bridge Rectifier,<br>ELECTRONIC DEVICES/<br>Equiv. (Interchange-<br>able with VARO VH<br>248) | 1                  |
| C1103                      | CGS222UO-<br>40BB10 |                  | • 2200 $\mu$ f, 40V Capacitor; 1<br>MALLORY/Equiv.                                              | 1                  |
| B1101                      |                     | 1-00-122         | • Battery Pack Assy.                                                                            | 1                  |



---

NAV-401L/402AP PARTS LIST

---

9-8 P.C. Card Cage Assy.

| Dwg/Ref<br>Symbol | Part<br>No. | IFR<br>Stock No. | Description                                                          | Qty<br>Per<br>Assy. |
|-------------------|-------------|------------------|----------------------------------------------------------------------|---------------------|
| 3-09-591          |             | 1-09-591         | P.C. Card Cage Assy.                                                 | REF                 |
|                   | STSM-2C4    |                  | • Standoff, SEAELECTRO/<br>Equiv.                                    | 7                   |
|                   | 50-30A-30   |                  | • Connector, CINCH/Equiv.                                            | 5                   |
|                   | 23071-5     |                  | • Card Guide, Natural;<br>SCANBE/Equiv.                              | 2                   |
|                   |             | 1-76-031         | • Card Guide, Scarlet;<br>SCANBE/Equiv.                              | 2                   |
|                   |             | 1-76-032         | • Card Guide, Green,<br>SCANBE/Equiv.                                | 2                   |
|                   |             | 1-76-033         | • Card Guide, Blue;<br>SCANBE/Equiv.                                 | 2                   |
|                   |             | 1-76-034         | • Card Guide, Black;<br>SCANBE/Equiv.                                | 2                   |
| Q224<br>& 225     | SJE-1462    |                  | • Transistor, MOTOROLA/<br>Equiv. (Interchange-<br>able with 2N5195) | 2                   |



9-9 Bearing Check Board Assy.

| Dwg/Ref<br>Symbol | Part<br>No.      | IFR<br>Stock No  | Description                                                          | Qty<br>Per<br>Assy |
|-------------------|------------------|------------------|----------------------------------------------------------------------|--------------------|
| 3-09-696          |                  | 1-09-696         | Bearing Check Board<br>Assy                                          | REF                |
| 3-09-713          |                  |                  | Bearing Check Board<br>Schematic                                     | REF                |
| Q4 &<br>8         | 2N2222           |                  | • Transistor, MOTOROLA/<br>Equiv. (Interchange-<br>able with 2N3415) | 2                  |
| Q5 &<br>6         | 66382            |                  | • Transistor, RCA/Equiv.<br>(Interchangeable with<br>2N5179)         | 2                  |
| Q2                | 2N5366           |                  | • Transistor, SOLID<br>STATE/Equiv.                                  | 1                  |
| Q1, 3<br>& 7      | 2N3251A          |                  | • Transistor, NATIONAL/<br>Equiv. (Interchange-<br>able with 2N5366) | 3                  |
| X4                | MC1709CG         |                  | • Op Amp, MOTOROLA/Equiv.<br>(Interchangeable with<br>LM709H)        | 1                  |
| X10<br>& 11       | 7490             |                  | • Logic, TI/Equiv.                                                   | 2                  |
| X1-3,<br>5-9      | 72558/<br>SN1458 |                  | • Op Amp, TI or SIG-<br>NETICS Only                                  | 8                  |
|                   | 8008-1G3         |                  | • Crystal Holder, AUGAT/<br>Equiv.                                   | 1                  |
| Y1                |                  | 3-76-0063-<br>18 | • • 10.0 MHz Antires-<br>onant Crystal, AUGAT/<br>Equiv.             | 1                  |
| CR1-10            | 1N4148           |                  | • Diode, SOLID STATE/<br>Equiv.                                      | 10                 |
| C23               | 538011A          |                  | • 5.5-18pf Trimmer Cap-<br>acitor, ERIE/Equiv.                       | 1                  |
| R18               | 62-1-1-<br>202   |                  | • 2K Trimpot, SPECTROL/<br>Equiv.                                    | 1                  |

---

NAV-401L/402AP PARTS LIST

---

9-9 Bearing Check Board Assy. (cont.)

| Dwg/Ref<br>Symbol | Part<br>No.      | IFR<br>Stock No. | Description                                | Qty<br>Per<br>Assy |
|-------------------|------------------|------------------|--------------------------------------------|--------------------|
| R28               | 62-1-1-<br>501   |                  | • 500 $\Omega$ Trimpot,<br>SPECTROL/Equiv. | 1                  |
| R50<br>& 52       | 62-1-1-<br>203   |                  | • 20 K Trimpot,<br>SPECTROL/Equiv.         | 2                  |
| R60               | 62-1-1-<br>103   |                  | • 10 K Trimpot,<br>SPECTROL/Equiv.         | 1                  |
| R63               | 62-1-1-<br>502   |                  | • 5 K Trimpot,<br>SPECTROL/Equiv.          | 1                  |
| TP1-7             | SKT-103-<br>PC-O |                  | • Test Point, TI/Equiv.                    | 7                  |

9-10 Regulator/Timer Board Assy.

| Dwg/Ref<br>Symbol                                   | Part<br>No. | IFR<br>Stock No. | Description                                                                                       | Qty<br>Per<br>Assy |
|-----------------------------------------------------|-------------|------------------|---------------------------------------------------------------------------------------------------|--------------------|
| 3-09-575                                            |             | 1-09-575         | Regulator/Timer PC Board REF<br>Assy.                                                             |                    |
| 3-09-422                                            |             |                  | Regulator/Timer Board<br>Schematic                                                                | REF                |
| X2                                                  | 72741L      |                  | • Op Amp, TI/Equiv.                                                                               | 1                  |
| X1                                                  | LM709H      |                  | • Op Amp, NATIONAL/<br>Equiv.                                                                     | 1                  |
| Q13                                                 | 2N2405      |                  | • Transistor, SOLID<br>STATE/Equiv.                                                               | 1                  |
| Q1, 3,<br>4, 5,<br>7, 10,<br>12, 15,<br>17, &<br>20 | 2N2222      |                  | • Transistor, SOLID<br>STATE/Equiv. (Eff:<br>S/N 1799 & on) (Inter-<br>changeable with<br>2N3415) | 10                 |
|                                                     | 2N3415      |                  | • Transistor, (Eff: to<br>S/N 1799) (Interchange-<br>able with 2N2222)                            |                    |
| Q1, 6,<br>8, 9,<br>11, 14,<br>16, 18<br>& 19        | 2N3251A     |                  | • Transistor, NATIONAL/<br>Equiv. (Interchange-<br>able with 2N5366)                              | 9                  |
| CR7, 8<br>& 19                                      | 1N4002      |                  | • Diode, TI/Equiv.                                                                                | 3                  |
| CR1, 2,<br>5, 6,<br>10-18,<br>20-27,<br>30-33       | 1N4148      |                  | • Diode, SOLID STATE/<br>Equiv.                                                                   | 2                  |
| CR4                                                 | 1N5240      |                  | • Diode, MOTOROLA/Equiv.                                                                          | 1                  |
| CR3 &<br>9                                          | 1N5234      |                  | • Diode, MOTOROLA/Equiv.                                                                          | 2                  |

NAV-401L/402AP PARTS LIST

9-10 Regulator/Timer Board Assy. (cont.)

| Dwg/Ref<br>Symbol  | Part<br>No.    | IFR<br>Stock No. | Description                                 | Qty<br>Per<br>Assy |
|--------------------|----------------|------------------|---------------------------------------------|--------------------|
| K1                 |                |                  | • DPDT Relay, ELECTRONIC SPECIALTIES/Equiv. | 1                  |
| R10                | 62-2-1-<br>501 |                  | • 500 $\Omega$ Trimpot, SPEC-TROL/Equiv.    | 1                  |
| R66                | 62-2-1-<br>102 |                  | • 1 K Trimpot, SPECTROL/Equiv.              | 1                  |
| R53,<br>60 &<br>64 | 62-2-1-<br>202 |                  | • 2 K Trimpot, SPECTROL/Equiv.              | 3                  |
| R20                | 62-2-1-<br>502 |                  | • 5 K Trimpot, SPECTROL/Equiv.              | 1                  |
| R62                | 62-2-1-<br>103 |                  | • 10 K Trimpot, SPEC-TROL/Equiv.            | 1                  |
| R72                | 62-2-1-<br>203 |                  | • 20 K Trimpot, SPEC-TROL/Equiv.            | 1                  |
| TP1                | SKT103PC-<br>0 |                  | • Test Point, TI/Equiv.                     | 1                  |

NAV-401L PARTS LIST

9-11 Combination Sine Board Assy

| Dwg/Ref<br>Symbol            | Part<br>No.      | IFR<br>Stock No. | Description                                                        | Qty Ref<br>Assy |
|------------------------------|------------------|------------------|--------------------------------------------------------------------|-----------------|
| 7010-0958-000                |                  | 7070-0958-000    | Combination Sine Board Assembly                                    | REF             |
| 0000-0943-000                |                  |                  | Combination Sine Board Schematic                                   | REF             |
| CR1-10<br>CR13-26<br>CR29-33 | 1N4148           |                  | Diode, SOLID STATE/<br>Equivalent                                  | 29              |
| X1-3<br>X5-10                | 72741L           | 3130-0000-025    | Op Amp, TI/Equiv.                                                  | 9               |
| X4                           | LM709H           | 3130-0000-004    | Op Amp, NATIONAL/<br>Equivalent                                    | 1               |
| Q5-9                         | 2N2222           | 4801-0000-001    | Transistor, MOTOROLA/<br>Equiv. (Interchange-<br>able with 2N3415) | 5               |
| Q3-4                         | 2N3251A          | 4805-0000-001    | Transistor, NATIONAL/<br>Equiv. (Interchange-<br>able with 2N5366) | 2               |
| Q1-2                         | 2N4223           | 5050-2601-000    | Transistor, NATIONAL/<br>Equivalent                                | 2               |
| R12, R46<br>& R89            | 62-2-1-<br>102   | 4753-0102-002    | 1 K Trimpot, SPECTROL/<br>Equivalent                               | 3               |
| R91 &<br>R86                 | 62-2-1-<br>202   | 4753-0202-002    | 2 K Trimpot, SPECTROL/<br>Equivalent                               | 2               |
| R6 &<br>R44                  | 62-2-1-<br>502   | 4753-0502-002    | 5 K Trimpot, SPECTROL/<br>Equivalent                               | 2               |
| R93                          | 62-2-1-<br>103   | 4753-0103-002    | 10 K Trimpot, SPECTROL/<br>Equivalent                              | 1               |
| TP1 &<br>TP2                 | SKT-103-<br>PC-0 | 4601-0000-001    | Test Point, TI/Equiv.                                              | 2               |



---

NAV-401L/402AP PARTS LIST

---

## 9-12 30 Hz Sine Board Assy.

| Dwg/Ref<br>Symbol              | Part<br>No.      | IFR<br>Stock No | Description                                                   | Qty.<br>Per<br>Assy. |
|--------------------------------|------------------|-----------------|---------------------------------------------------------------|----------------------|
| 3-09-708                       |                  | 1-09-708        | 30 Hz Sine Board Assy                                         | REF                  |
| 3-09-722                       |                  |                 | 30 Hz Sine Board<br>Schematic                                 | REF                  |
| X1 &<br>8                      | 72741L           |                 | • Op Amp, TI/Equiv.                                           | 2                    |
| X7                             | LM709H           |                 | • Op Amp, NATIONAL/<br>Equiv.                                 | 1                    |
| X3                             | CD4040AE         |                 | • Logic, RCA/Equiv.                                           | 1                    |
| X4                             | CD4011AE         |                 | • Logic, RCA/Equiv.                                           | 1                    |
| X2, 5,<br>6 & 9                | 72558/<br>MC4158 |                 | • Op Amp, TI or<br>SIGNETICS Only                             | 4                    |
| Q1, 3,<br>8, 10,<br>11 &<br>13 | 2N2222           |                 | • Transistor, MOTOROLA/<br>Equiv. (Eff: S/N<br>1959 and on)   | 6                    |
|                                | 2N3415           |                 | • Transistor, SOLID<br>STATE/Equiv. (Eff:<br>to S/N 1959)     |                      |
| Q2, 6,<br>7, 9<br>& 12         | 2N3251A          |                 | • Transistor, SOLID<br>STATE/Equiv. (Eff:<br>S/N 1959 and on) | 5                    |
|                                | 2N5366           |                 | • Transistor, SOLID<br>STATE/Equiv. (Eff:<br>to S/N 1959)     |                      |
| Q4 &<br>5                      | 2N4223           |                 | • Transistor, NATIONAL/<br>Equiv. (Eff: S/N 1959<br>and on)   | 2                    |
|                                | UC714            |                 | • Transistor, UNION<br>CARBIDE/Equiv. (Eff:<br>to S/N 1959)   |                      |

---

NAV-401L/402AP PARTS LIST

---

## 9-12 30 Hz Sine Board Assy. (cont.)

| Dwg/Ref<br>Symbol                                     | Part<br>No.    | IFR<br>Stock No. | Description                                  | Qty.<br>Per<br>Assy. |
|-------------------------------------------------------|----------------|------------------|----------------------------------------------|----------------------|
| CR1-14,<br>17-33,<br>36-49,<br>52-58                  | 1N4148         |                  | • Diode, SOLID STATE/<br>Equiv.              | 52                   |
| R9 &<br>92                                            | 62-1-1-<br>501 |                  | • 500 $\Omega$ Trimpot, SPEC-<br>TROL/Equiv. | 2                    |
| R37                                                   | 62-1-1-<br>202 |                  | • 2 K Trimpot, SPECTROL/<br>Equiv.           | 1                    |
| R33 &<br>51                                           | 62-1-1-<br>502 |                  | • 5 K Trimpot, SPECTROL/<br>Equiv.           | 2                    |
| R1, 6,<br>33, 35,<br>53, 54,<br>60, 61,<br>82 &<br>89 | 62-1-1-<br>103 |                  | • 10 K Trimpot, SPEC-<br>TROL/Equiv.         | 10                   |
| R16                                                   | 62-1-1-<br>203 |                  | • 20 K Trimpot, SPEC-<br>TROL/Equiv.         | 1                    |
| TP1-3                                                 | SKT103PC-<br>0 |                  | • Test Point, TI/Equiv.                      | 3                    |

---

NAV-401L PARTS LIST

---

9-13 VOR Bearing Logic Board Assy

| Dwg/Ref<br>Symbol      | Part<br>No.     | IFR<br>Stock No. | Description                          | Qty. Per<br>Assy |
|------------------------|-----------------|------------------|--------------------------------------|------------------|
| 7010-0958-100          |                 | 7010-0958-100    | VOR Bearing Logic Board<br>Assembly  | REF              |
| 0000-0942-700          |                 |                  | VOR Bearing Logic Board<br>Schematic | REF              |
| X1, X5 &<br>X10        | 7400            | 3130-0000-001    | Logic, TI/Equiv.                     | 3                |
| X13                    | 7420            | 3130-0000-006    | Logic, TI/Equiv                      | 1                |
| X4                     | 7430            | 3130-0000-007    | Logic, TI/Equiv                      | 1                |
| X9, X11<br>X16 & X20   | 7473            | 3130-0000-010    | Logic, TI/Equiv                      | 4                |
| X6-8<br>X14,<br>X17-19 | 7490            | 3130-0000-013    | Logic, TI/Equiv                      | 7                |
| X2, X3<br>& X15        | 7492            | 3130-0000-014    | Logic, TI/Equiv                      | 3                |
| X12                    | 74121           | 3130-0000-017    | Logic, TI/Equiv                      | 1                |
| Q1                     | 2N3646          | 4805-0000-003    | Transistor, NATIONAL/<br>Equivalent  | 1                |
|                        | 8008-1G3        | 2301-0000-006    | Crystal Holder,<br>AUGAT/Equivalent  | 1                |
|                        |                 | 3107-0931-200    | Insulator, Crystal                   | 1                |
|                        |                 | 2363-0021-000    | 2.16 MHz Crystal,<br>kw/Equivalent   | 1                |
| CR1-14                 | 1N270           | 4814-0000-002    | Diode, SOLID STATE/<br>Equivalent    | 14               |
| TP1-6                  | SKT103-<br>PC-0 | 4601-0000-001    | Test Point, TI/Equiv.                | 6                |



# NAV-401L PARTS LIST

## 9-14 5 Volt Regulator Assy.

| Dwg/Ref<br>Symbol  | Part<br>No.    | IFR<br>Stock No. | Description                                                     | Qty Per<br>Assy. |
|--------------------|----------------|------------------|-----------------------------------------------------------------|------------------|
| 7023-0973-100      |                | 7023-0973-100    | 5 Volt Regulator Assy REF                                       |                  |
| X1152              | LM305          | 3135-0000-006    | Voltage Regulator,<br>NATIONAL/Equiv.                           | 1                |
| X1151              | P1C-600        | 3135-0000-007    | Voltage Regulator,<br>UNITRIDE/Equiv.                           | 1                |
| CR1151 &<br>CR1152 | 1N4148         | 4815-0000-003    | Diode                                                           | 2                |
| Q1151              | 2N2222         | 4801-0000-001    | Transistor, MOTOROLA/<br>Equivalent                             | 1                |
| R1158              | 62-1-1-<br>501 | 4753-0501-002    | Round Trim Pot,<br>SPECTROL/EQUIV. (Eff:<br>S/N 1636 and on)    | 1                |
|                    | 62-1-1-<br>102 |                  | Round Trim Pot,<br>SPECTROL/EQUIV. (Eff:<br>S/N 1635 and prior) | 1                |
| L1153              |                | 1800-0973-200    | Wound 30-Turn Coil<br>Assembly                                  | 1                |
| L1151              |                | 1800-0973-301    | 3 <sup>1</sup> / <sub>2</sub> Turn Coil Assy.                   | 1                |
| L1152              |                | 1800-0973-302    | 4 Turn Coil Assy.                                               | 1                |
| J1151              | 205734-1       | 2116-0000-014    | 9 Pin Connector, AMP/<br>Equivalent                             | 1                |



---

NAV-401L/402AP PARTS LIST

---

9-15-1 Prescaler (Eff: to S/N 2215, S/N 2218-2271)

| Dwg/Ref<br>Symbol | Part<br>No.   | IFR<br>Stock No. | Description                                                       | Qty<br>Per<br>Assy. |
|-------------------|---------------|------------------|-------------------------------------------------------------------|---------------------|
| 3-09-545          |               |                  | Schematic                                                         | REF                 |
|                   |               | 1-09-598         | Prescaler Assy.                                                   | 1                   |
| PC-10             |               | 1-09-599         | • Prescaler Board Assy.                                           | 1                   |
|                   |               | 1-09-477         | • • Prescaler PC Board                                            | 1                   |
| X4-X6             | MC1027L       |                  | • • Logic, MOTOROLA/<br>Equiv.                                    | 3                   |
| X2 & X3           | MC1666L       |                  | • • Logic, MOTOROLA/<br>Equiv.                                    | 2                   |
| X1                | MC1692L       |                  | • • Op Amp, MOTOROLA/<br>Equiv.                                   | 1                   |
| X7                | 7490          |                  | • • Logic, TI/Equiv.                                              | 1                   |
| X8                | 72741L        |                  | • • Op Amp, TI/Equiv.                                             | 1                   |
| Q8                | 2N3646        |                  | • • Transistor, NATION-<br>AL/Equiv.                              | 1                   |
| Q5-7              | 2N3905        |                  | • • Transistor, NATION-<br>AL/Equiv.                              | 3                   |
| Q1-4              | 66382         |                  | • • Transistor, RCA/<br>Equiv. (Interchange-<br>able with 2N5179) | 4                   |
| CR2, 5<br>& 6     | 1N4148        |                  | • • Diode, SOLID STATE/<br>Equiv.                                 | 3                   |
| CR4               | 1N5231        |                  | • • Diode, DICKSON/Equiv.                                         | 1                   |
| CR3               | 1N5234        |                  | • • Diode, DICKSON/Equiv.                                         | 1                   |
| CR1 &<br>7        | MA47047       |                  | • • Diode, MICROWAVE<br>ASSOCIATES/Equiv.                         | 2                   |
| C14-18            | FA5C-<br>102W |                  | • • 100 pf Feed Thru<br>Capacitor, ALLEN-<br>BRADLEY/Equiv.       | 5                   |

---

NAV-401L/402AP PARTS LIST

---

9-15-1 Prescaler (cont.)

| Dwg/Ref<br>Symbol | Part<br>No. | IFR<br>Stock No. | Description                                                | Qty<br>Per<br>Assy. |
|-------------------|-------------|------------------|------------------------------------------------------------|---------------------|
| C13 &<br>28       | FA5C470W    |                  | • • 47 pf Feed Thru<br>Capacitor, ALLEN-<br>BRADLEY/Equiv. | 2                   |
| J1001             |             | 1-76-052-1       | • Connector, Modified;<br>AMERICON/Equiv.                  | 1                   |
| J1002             |             | 1-76-052-2       | • Connector, Modified;<br>AMERICON/Equiv.                  | 1                   |
| P1003             | 25204-1     |                  | • Plug, 9-Pin; AMP/Equiv.                                  | 1                   |

---

NAV-401L/402AP PARTS LIST

---

9-15-2 Prescaler (Eff: S/N 2215-2217, 2272 and on)

| Dwg/Ref<br>Symbol | Part<br>No. | IFR<br>Stock No. | Description                                                 | Qty.<br>Per<br>Assy. |
|-------------------|-------------|------------------|-------------------------------------------------------------|----------------------|
| 3-09-743          |             |                  | Schematic                                                   | REF                  |
|                   |             | 1-09-766         | Prescaler Assy.                                             | 1                    |
| 1-09-750          |             | 1-09-750         | • Prescaler Bd. Assy.                                       | 1                    |
|                   |             | 2-09-744         | • • Prescaler PC Bd.                                        | 1                    |
| X1                | MC12013L    |                  | • • Logic, MOTOROLA/<br>Equiv.                              | 1                    |
| X2 & 3            | 74S112      |                  | • • Logic, TI/Equiv.                                        | 2                    |
| X4                | 7400        |                  | • • Logic, TI/Equiv.                                        | 1                    |
| Q1 & 2            | MRF911      |                  | • • Transistor,<br>MOTOROLA/Equiv.                          | 2                    |
| CR1-6             | MA47047     |                  | • • Diode, MICROWAVE<br>ASSOCIATES/Equiv.                   | 6                    |
| R13               | 62-1-1-201  |                  | • • 200Ω Trimpot,<br>SPECTROL/Equiv.                        | 1                    |
| C12,13<br>& 14    | FA5C-102W   |                  | • • 1000pf Feed Thru<br>Capacitor, ALLEN-<br>BRADLEY/Equiv. | 3                    |
| C15               | FA5C-470W   |                  | • • 47pf Feed Thru<br>Capacitor, ALLEN-<br>BRADLEY/Equiv.   | 1                    |
| P1003             | 205204-1    |                  | • Plug, 9-Pin, AMP/<br>Equiv.                               | 1                    |
| J1001 & 2         | 60-0911-092 |                  | • Connector, AEP/<br>Equiv.                                 | 2                    |



# NAV-401L PARTS LIST

## 9-16 Oscillator Assembly

| Dwg/Ref<br>Symbol  | Part<br>No.        | IFR<br>Stock No. | Description                                                          | Qty Per<br>Assy. |
|--------------------|--------------------|------------------|----------------------------------------------------------------------|------------------|
| 7010-0959-XXX      |                    | 7010-0959-401    | Oscillator Assy                                                      | REF              |
| 0000-0954-900      |                    |                  | Oscillator Schematic                                                 | REF              |
| P701               | 205206-1           |                  | 15 Pin Plug, Amp/Equiv.                                              | 1                |
| FL1-14             | 51-703-001         |                  | RF Feedthrough,<br>SPECTRUM CONTROL/Equiv.                           | 14               |
| J701 &<br>J702     | 27-9               |                  | Connector, AMERCON/<br>Equivalent                                    | 2                |
| PC-7               |                    | 1-09-594         | Oscillator PC Board Assy                                             | 1                |
|                    |                    | 3-09-469         | Oscillator PC Board                                                  | 1                |
| CR712              | 1N823              |                  | Diode, SOLID STATE/<br>Equiv. (Eff: S/N<br>1311 and on)              | 1                |
| CR705              | 1N5231             | 4818-0000-003    | Diode, MOTOROLA/<br>Equiv. (Eff: S/N<br>1311 and on)                 | 1                |
| CR1, 3<br>4, 6 & 7 | 1N4148             | 4815-0000-003    | Diode, SOLID STATE/<br>Equivalent                                    | 5                |
| CR8-10             | MA47047            | 4828-0000-002    | Diode, MICROWAVE<br>ASSOCIATES/Equiv                                 | 3                |
| CR711              | PC0600D            |                  | Diode, PARAMETRICS/<br>Equiv. (Eff: to S/N 2654)                     | 1                |
| CR711              | PC0600D<br>SPECIAL | 4930-0100-200    | Diode, PARAMETRICS/<br>Equiv. (Eff: S/N 2655<br>and on)              | 1                |
| X1                 | 72741L             | 3130-0000-025    | Op Amp, TI/Equiv.                                                    | 1                |
| Q3                 | 2N325              | 4805-0000-001    | Transistor, SOLID<br>STATE/Equiv. (Inter-<br>changeable with 2N5366) | 1                |
| Q6-10              | 2N3905             | 4807-0000-002    | Transistor, NATIONAL/<br>Equivalent                                  | 5                |

---

NAV-401L PARTS LIST

---

## 9-16 Oscillator Assembly (Cont'd)

| Dwg/Ref<br>Symbol | Part<br>No.      | IFR<br>Stock No. | Description                            | Qty Per<br>Assy. |
|-------------------|------------------|------------------|----------------------------------------|------------------|
| R46               | 61-1-4-<br>202   | 4752-0202-002    | 2 K Trimpot, SPECTROL/<br>Equivalent   | 1                |
| R45               | 61-1-4-<br>502   | 4752-0502-002    | 5 K Trimpot, SPECTROL/<br>Equivalent   | 1                |
| L-3               | SK-425-1         | 1804-0000-002    | Coil, Natural;<br>PAUL-SMITH/Equiv.    | 1                |
| L-4               | SK-425-2         | 1804-0000-006    | Coil, Violet;<br>PAUL-SMITH/Equiv      | 1                |
| L-11-<br>L-14     | SK-426-2         | 1804-0000-004    | Coil, Orange;<br>PAUL-SMITH/Equiv      | 4                |
| L-6 &<br>L-10     | SK-426-3         | 1804-0000-005    | Coil, Yellow;<br>PAUL-SMITH/Equiv      | 2                |
| L-5               | SK-426-4         | 1804-0000-007    | Coil, Black<br>PAUL-SMITH/Equiv        | 1                |
| Y-4               |                  | 3-76-0063-13     | 75.0 MHz Crystal<br>K.W./Equivalent    | 1                |
| Y-5               |                  | 3-76-0063-14     | 108.0 MHz Crystal<br>K.W./Equivalent   | 1                |
| Y-3               |                  | 3-76-0063-15     | 108.1 MHz Crystal<br>K.W./Equivalent   | 1                |
| Y-1               |                  | 3-76-0063-16     | 111.566 MHz Crystal<br>K.W./Equivalent | 1                |
| Y-2               |                  | 3-76-0063-17     | 126.9 MHz Crystal<br>K.W./Equivalent   | 1                |
|                   | 1-380737-<br>0-1 |                  | Receptacle, AMP/<br>Equivalent         | 10               |
| L-17              |                  | 1-09-0626        | Coil Assembly                          | 1                |

---

NAV-401L/402AP PARTS LIST

---

9-17 Phase-Lock Range Extender (Optional on NAV-401L)

| Dwg/Ref<br>Symbol | Parts<br>No.      | IFR<br>Stock No. | Description                                                 | Qty.<br>Per<br>Assy |
|-------------------|-------------------|------------------|-------------------------------------------------------------|---------------------|
|                   |                   | 1-09-579         | Phase-Lock Range Ex-<br>tender Assembly                     | REF                 |
| 3-09-666          |                   |                  | Oscillator Schematic                                        | REF                 |
| X2                | 72558P            |                  | • Dual Op Amp, TI/<br>Equiv.                                | 1                   |
| R56               | 62-2-1-<br>203    |                  | • 20 K Trimpot, SPEC-<br>TROL/Equiv.                        | 1                   |
|                   |                   |                  | The following items are<br>installed on the Front<br>Panel: |                     |
|                   | RV6NAYSD-<br>253A | 1-76-0003        | • 25 K Trimpot, CLARO-<br>STAT/Equiv.                       | 1                   |
|                   |                   | 1-76-0132        | • Dual 10 K, 10 Turn<br>Trimpot Assy.                       | 1                   |



9-18 Buffer Amp Assy.

| Dwg/Ref<br>Symbol | Part<br>No.     | IFR<br>Stock No. | Description                                            | Qty<br>Per<br>Assy |
|-------------------|-----------------|------------------|--------------------------------------------------------|--------------------|
| 2-09-703          |                 | 1-09-703         | Buffer Amp Assy.                                       | REF                |
| 2-09-667          |                 |                  | Buffer Amp Schematic                                   | REF                |
|                   | FA5C-<br>102W   |                  | • 1000 pf Feedthrough<br>Cap, ALLEN-BRADLEY/<br>Equiv. | 1                  |
| J1-J3             | 50-045-<br>0000 |                  | • SMC Male Connector,<br>SEAELECTRO/Equiv.             | 3                  |
| PC-15             |                 | 1-09-637         | • Buffer Amp PC Board<br>Assy.                         | 1                  |
| Q1-3              | 66382           |                  | • • Transistor, RCA/<br>Equiv.                         | 3                  |
| L1 & 2            | 1025-52         |                  | • • 22 $\mu$ h Choke,<br>DELEVAN/Equiv.                | 2                  |



---

NAV-401L/402AP PARTS LIST

---

9-19 Phase-Lock Power Monitor Assy.

| Dwg/Ref<br>Symbol | Part<br>No.     | IFR<br>Stock No. | Description                           | Qty<br>Per<br>Assy |
|-------------------|-----------------|------------------|---------------------------------------|--------------------|
| 3-09-604          |                 | 1-09-604         | Phase-Lock Power<br>Monitor Assy.     | REF                |
| 3-09-438          |                 |                  | Phase-Lock Power<br>Monitor Schematic | REF                |
| Q54               | 2N4223          |                  | • Transistor, NATION-<br>AL/Equiv.    | 1                  |
| Q52 &<br>53       | 2N3646          |                  | • Transistor, NATION-<br>AL/Equiv.    | 2                  |
| Q51               | 2N3905          |                  | • Transistor, NATION-<br>AL/Equiv.    | 1                  |
| Q55               | 2N5462          |                  | • Transistor, MOTOROLA/<br>Equiv.     | 1                  |
| X1                | 72741L          |                  | • Op Amp, TI/Equiv.                   | 1                  |
| R5                | 62-1-1-<br>102  |                  | • 1 K Trimpot, SPECTROL/<br>Equiv.    | 1                  |
| CR1               | MS7440          |                  | • Diode, SOLITRON/Equiv.              | 1                  |
| CR2               | 5082-<br>2800   |                  | • Diode, HEWLETT-PACK-<br>ARD/Equiv.  | 1                  |
| P901              | 205736-2        |                  | • 15 Pin Receptacle,<br>AMP/Equiv.    | 1                  |
| P902              | 64-9907-<br>003 |                  | • Connector, AEP/Equiv.               | 1                  |



---

NAV-401L PARTS LIST

---

9-20 Attenuator/Transmitter Assy.

| Dwg/Ref<br>Symbol | Part<br>No.   | IFR<br>Stock No | Description                                            | Qty<br>Per<br>Assy. |
|-------------------|---------------|-----------------|--------------------------------------------------------|---------------------|
| 3-09-588          |               | 1-09-588        | Attenuator Transmitter<br>Assy.                        | REF                 |
| 3-09-550          |               |                 | Modulator, PA & Atten-<br>uator Schematic              | REF                 |
| AT1               |               | 1-09-497        | • Attenuator Assy.                                     | 1                   |
|                   | RG-188<br>A/U |                 | • • Coax Cable, BELDEN/<br>Equiv.                      | As<br>Req'd         |
| CR815             | 5082-<br>2800 |                 | • • Diode, HEWLETT-<br>PACKARD/Equiv.                  | 1                   |
|                   | STFM-<br>2C4  |                 | • • Terminal, SEAELECTRO/<br>Equiv.                    | 3                   |
| K801              |               | 1-76-028        | • • Relay, ELECTRONIC<br>SPECIALTIES/Equiv.            | 1                   |
| CR816             | 1N4148        |                 | • • Diode, SOLID STATE/<br>Equiv.                      | 1                   |
| CR814             | MA47047       |                 | • • Diode, MICROWAVE<br>ASSOCIATES/Equiv.              | 1                   |
| L820              |               | 1-09-527        | • • 10 Turn Coil                                       | 1                   |
|                   |               | 1-09-492        | • • Back Plate Assy                                    | 1                   |
|                   |               | 1-09-597        | • • Tripler PC Board<br>Assy.                          | 1                   |
|                   |               | 1-09-518        | • • Tripler PC Board                                   | 1                   |
| L817<br>& 818     |               | 1-09-530        | • • Tripler Coil                                       | 2                   |
| Q810-<br>812      | 2N5179        |                 | • • Transistor, RCA/<br>Equiv. (Eff: S/N<br>1841 & on) | 3                   |
|                   | 66382         |                 | • • Transistor, (Eff:<br>to S/N 1841)                  |                     |

---

NAV-401L PARTS LIST

---

9-20 Attenuator/Transmitter Assy. (cont.)

| Dwg/Ref<br>Symbol | Part<br>No.  | IFR<br>Stock No. | Description                                                   | Qty<br>Per<br>Assy |
|-------------------|--------------|------------------|---------------------------------------------------------------|--------------------|
| C809<br>& 810     | NVC-9GW      |                  | • • Variable Capacitor,<br>JFD/Equiv.                         | 2                  |
|                   | 27-9         |                  | • • Connector, AMPHENOL/<br>Equiv.                            | 1                  |
| 3-09-585          |              | 1-09-585         | • • Transmitter PC Board<br>Assy.                             | 1                  |
| Q813-<br>816      | 66382        |                  | • • Transistor, RCA/<br>Equiv. (Eff: S/N<br>1841 and on)      | 4                  |
|                   | 2N5179       |                  | • • Transistor (Eff: to<br>1841)                              |                    |
| Q817              | 2N3251A      |                  | • • Transistor, NATIONAL/<br>Equiv. (Eff: S/N 1690<br>and on) | 1.                 |
|                   | 2N5366       |                  | • • Transistor, (Eff: to<br>S/N 1690)                         |                    |
| CR817             | 1N4148       |                  | • • Diode, SOLID STATE/<br>Equiv.                             | 1                  |
| L819              |              | 1-09-528         | • • 5 and 7 Turn Tank<br>Coil                                 | 1                  |
| C818              |              | 1-90-702         | • • 2.7 - 19 pf Tuning<br>Cap                                 | 1                  |
|                   | 250206-<br>1 |                  | • • Connector, AMP/Equiv.                                     | 1                  |
|                   | 205089-<br>1 |                  | • • Male Solder Pin,<br>AMP/Equiv.                            | 3                  |
| 3-09-596          |              | 1-09-596         | • Modulator PC Board<br>Assy.                                 | 1                  |
| X801<br>& 802     | 72741L       |                  | • • Op Amp, TI/Equiv.                                         | 2                  |
| Q805<br>- 809     | 2N4223       |                  | • • Transistor, NATION-<br>AL/Equiv.                          | 5                  |

NAV-401L PARTS LIST

9-20 Attenuator/Transmitter Assy. (cont.)

| Dwg/Ref<br>Symbol | Part<br>No.    | IFR<br>Stock No. | Description                                                     | Qty<br>Per<br>Assy. |
|-------------------|----------------|------------------|-----------------------------------------------------------------|---------------------|
| Q804<br>& 803     | 2N2222         |                  | • • Transistor, SOLID<br>STATE/Equiv. (Eff:<br>S/N 1690 and on) | 2                   |
|                   | 2N3415         |                  | • • Transistor, (Eff:<br>to S/N 1690)                           |                     |
| Q801<br>& 802     | 2N3251A        |                  | • • Transistor, SOLID<br>STATE/Equiv. (Eff:<br>S/N 1690 and on) | 2                   |
|                   | 2N5366         |                  | • • Transistor, (Eff:<br>to S/N 1690)                           |                     |
| CR801<br>- 813    | 1N4148         |                  | • • Diode, SOLID STATE/<br>Equiv.                               | 13                  |
| R810              | 62-2-1-<br>503 |                  | • • 50 K Trimpot, SPEC-<br>TROL/Equiv.                          | 1                   |
|                   |                | 1-09-170         | • Adapter, Flex Shaft                                           | 1                   |
|                   |                | 1-09-171         | • Adapter, Flex Shaft                                           | 1                   |
|                   |                | 1-09-235         | • • Flexible Shaft                                              | 1                   |



---

NAV-401L PARTS LIST

---

9-21 Localizer/Transmitter Assy.

| Dwg/Ref<br>Symbol. | Part<br>No.      | IFR<br>Stock No. | Description                               | Qty.<br>Per<br>Assy. |
|--------------------|------------------|------------------|-------------------------------------------|----------------------|
| 3-09-589           |                  | 1-09-589         | Localizer/Transmitter<br>Assy.            | REF                  |
| 3-09-548           |                  |                  | Localizer/Transmitter<br>Schematic        | REF                  |
| 3-09-590           |                  | 1-09-590         | • Localizer/Transmitter<br>PC Board Assy. | 1                    |
| X1                 | 72741L           |                  | • • Op Amp, TI/Equiv.                     | 1                    |
|                    | 380737-<br>0     |                  | • • Receptacle, AMP/<br>Equiv.            | 2                    |
| Y1                 | 3-76-0063<br>-15 |                  | • • • 108.1 MHz Crystal,<br>K.W./Equiv.   | 1                    |
| L1 &<br>L3         | SK-426-2         |                  | • • Coil, Orange; PAUL-<br>SMITH/Equiv.   | 2                    |
| Q4                 | 2N2222           |                  | • • Transistor, MOTO-<br>ROLA/Equiv.      | 1                    |
| Q2 &<br>3          | 66382            |                  | • • Transistor, RCA/<br>Equiv.            | 2                    |
| Q1                 | 2N3905           |                  | • • Transistor, NATION-<br>AL/Equiv.      | 1                    |
| CR3                | 5082-<br>2800    |                  | • • Diode, HEWLETT-<br>PACKARD/Equiv.     | 1                    |
| CR1 &<br>2         | 1N4148           |                  | • • Diode, SOLID STATE/<br>Equiv.         | 2                    |
| J1                 | 17-104-<br>000   |                  | • • Connector, AEP/Equiv.                 | 1                    |
|                    | 205089-1         |                  | • • Male Solder Pin                       | 2                    |



---

NAV-401L/402AP PARTS LIST

---

9-22 Diode Protect Block Assy.

| Dwg/Ref<br>Symbol | Part<br>No. | IFR<br>Stock No. | Description                        | Qty.<br>Per<br>Assy. |
|-------------------|-------------|------------------|------------------------------------|----------------------|
| 2-09-586          |             | 1-09-586         | Diode Protect Block<br>Assy.       | REF                  |
| 3-09-548          |             |                  | Localizer/Transmitter<br>Schematic | REF                  |
| J4                | 2052-2      |                  | • Connector, AMERICON/<br>Equiv.   | 1                    |
| J3                | UG-1094/U   |                  | • Connector, AMPHENOL/<br>Equiv.   | 1                    |
| J5                | 27-9        |                  | • Connector, AMPHENOL/<br>Equiv.   | 1                    |
| CR1-4             | 1N4148      |                  | • Diode, SOLID STATE/<br>Equiv.    | 4                    |



---

NAV-401L/402AP PARTS LIST

---

| 9-23 160 MHz Low Pass Filter Assy. (Installed at Mfgr's Option) |                 |                  |                                             |                     |
|-----------------------------------------------------------------|-----------------|------------------|---------------------------------------------|---------------------|
| and                                                             |                 |                  |                                             |                     |
| Dwg/Ref<br>Symbol                                               | Part<br>No.     | IFR<br>Stock No. | Description                                 | Qty<br>Per<br>Assy. |
| 2-09-764                                                        |                 | 1-09-764         | 160 MHz Low Pass Filter<br>Assy.            | REF                 |
| 1-09-763                                                        |                 |                  | 160 MHz Low Pass Filter<br>Schematic        | REF                 |
| P1 &<br>2                                                       | 17-0104-<br>000 |                  | . Connector, AEP/Equiv.                     | 2                   |
|                                                                 |                 | 1-09-774         | . 3 3/4" Flexible Coax<br>Assy.             | 1                   |
|                                                                 | RG-188/U        |                  | . . Flexible Coax                           | As<br>Reqd.         |
|                                                                 | 17-302-188      |                  | . . SMC Female<br>Connector, AEP/<br>Equiv. | 2                   |



---

NAV-401L/402AP PARTS LIST

---

9-24 RF Cable Assys.

| Dwg/Ref<br>Symbol | Part<br>No.     | IFR<br>Stock No. | Description                           | Qty.<br>Per<br>Assy. |
|-------------------|-----------------|------------------|---------------------------------------|----------------------|
|                   |                 | 3-09-540-1       | 18" Flexible Coax<br>Assy.            | 1                    |
|                   | 64-9907-<br>003 |                  | • SMA Male Connector,<br>AEP/Equiv.   | 1                    |
|                   | 17-0302-<br>188 |                  | • SMC Female Connector.<br>AEP/Equiv. | 1                    |
|                   | RG-188/U        |                  | • Flexible Coax,<br>BELDEN/Equiv.     | As<br>Reqd.          |
|                   |                 | 3-09-540-2       | 7½" Flexible Coax Assy.               | 2                    |
|                   | 17-0302-<br>188 |                  | • SMC Female Connector,<br>AEP/Equiv. | 4                    |
|                   | RG-188/U        |                  | • Flexible Coax, BELDEN/<br>Equiv.    | As<br>Reqd.          |
|                   |                 | 3-09-540-3       | 14" Flexible Coax Assy.               | 1                    |
|                   | 17-0302-<br>188 |                  | • SMC Female Connector,<br>AEP/Equiv. | 2                    |
|                   | RG-188/U        |                  | • Flexible Coax, BELDEN/<br>Equiv.    | As<br>Reqd.          |
|                   |                 | 3-09-540-4       | 7½" Flexible Coax Assy.               | 1                    |
|                   | 64-9907-<br>003 |                  | • SMA Male Connector,<br>AEP/Equiv.   | 1                    |
|                   | 6399            |                  | • BNC Male Connector,<br>GREMAR/Equiv | 1                    |
|                   | RG-188/U        |                  | • Flexible Coax,<br>BELDEN/Equiv.     | As<br>Reqd.          |



---

NAV-401L PARTS LIST

---

9-25 Case Assy.

| Dwg/Ref<br>Symbol | Part<br>No. | IFR<br>Stock No. | Description                         | Qty<br>Per<br>Assy |
|-------------------|-------------|------------------|-------------------------------------|--------------------|
|                   |             | 1-09-600         | Case Assy                           | 1                  |
|                   |             | 3-09-109         | Lid Assy, ZERO                      | 1                  |
|                   |             | 1-09-099         | Antenna Assy                        | 1                  |
|                   |             | 2-09-089         | • Carrying Handle                   | 1                  |
|                   |             | 1-09-088         | • Handle Locking Stud               | 2                  |
|                   |             | 2-76-002-4       | • Washer                            | 4                  |
|                   |             | 1-09-086         | • Thumb Screw                       | 2                  |
|                   | 586-210     |                  | • O-Ring, NATIONAL<br>O-RING/Equiv. | 1                  |
|                   |             | 1-76-072         | • Grommet, RUSSELL<br>IND./Equiv.   | 2                  |
|                   |             | 2-09-443         | • Decal                             | 1                  |
|                   |             | 1-75-014         | • Type Acceptance Tag               | 1                  |
|                   |             | 1-76-073         | • Foot                              | 8                  |
|                   |             | 1-75-003         | • Pairing Chart                     | 1                  |
|                   |             | 1-75-022         | • Serial Tag                        | 1                  |
|                   |             | 1-08-151         | • Card Retainer Plate               | 1                  |
|                   |             | 1-08-152         | • Fastener, Card<br>Retainer Plate  | 2                  |



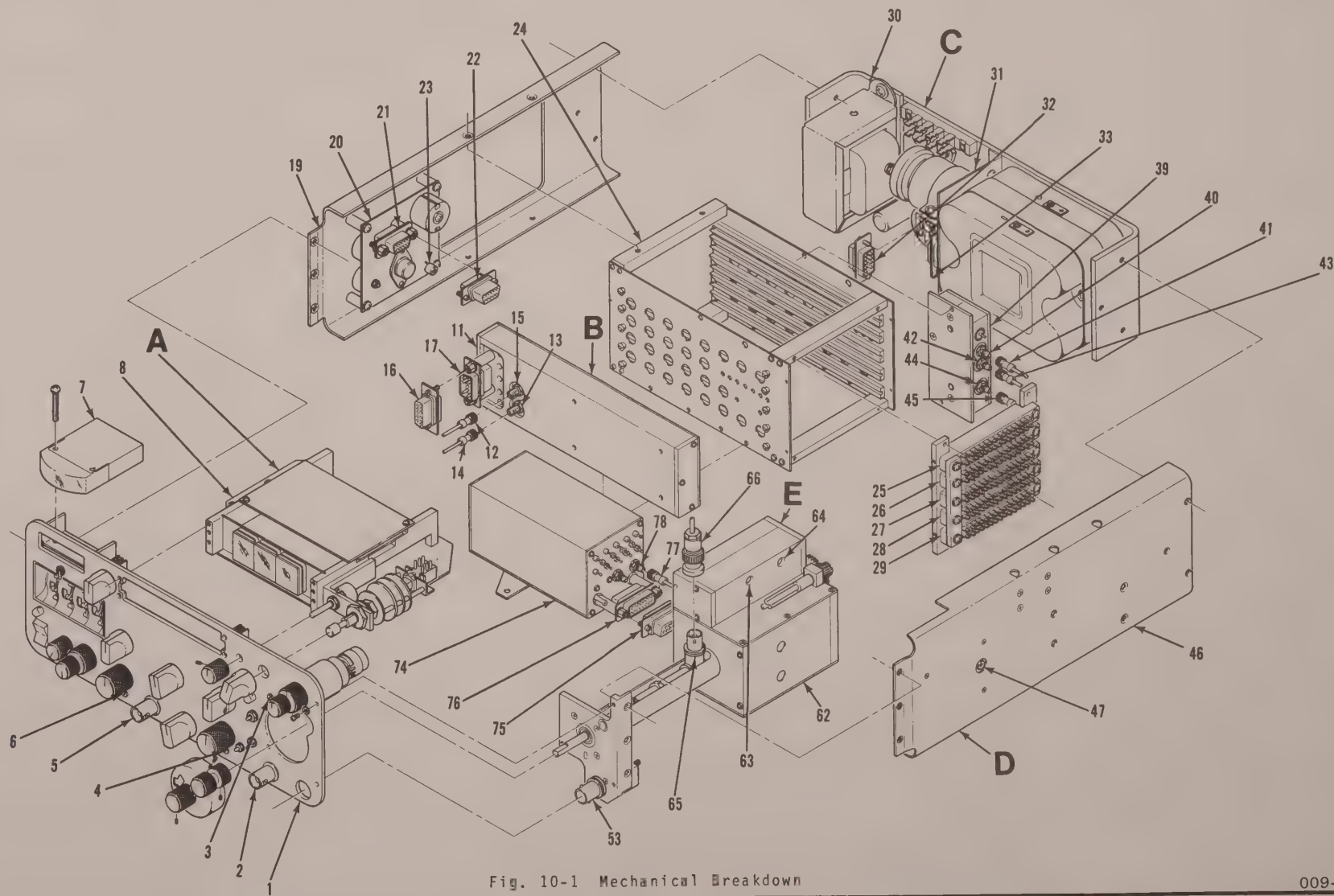
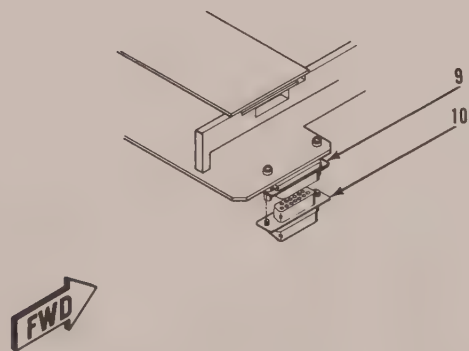


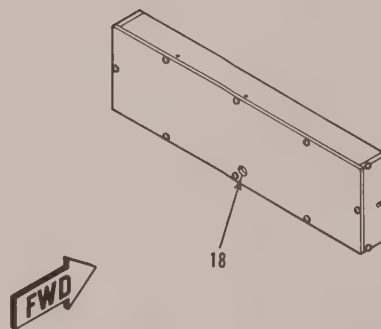
Fig. 10-1 Mechanical Breakdown

009-0779-015

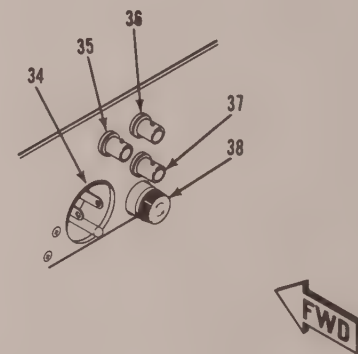




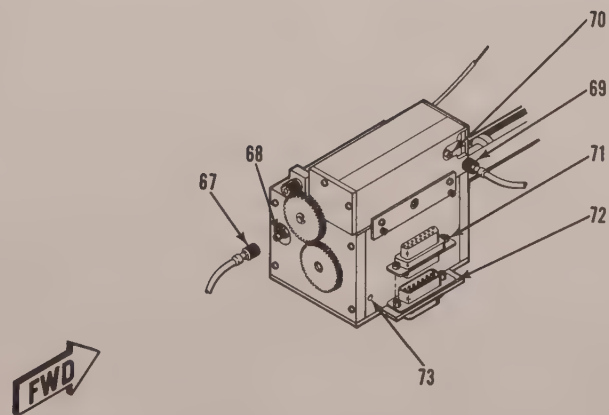
Detail **A**



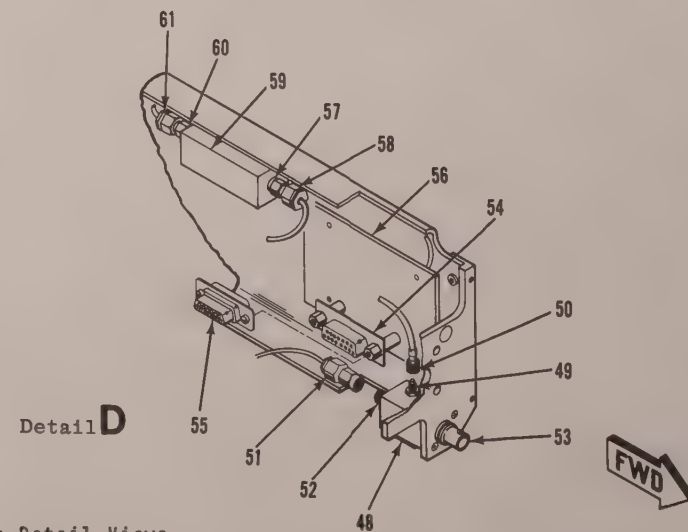
Detail **B**



Detail **C**



Detail **E**



Detail **D**

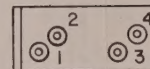
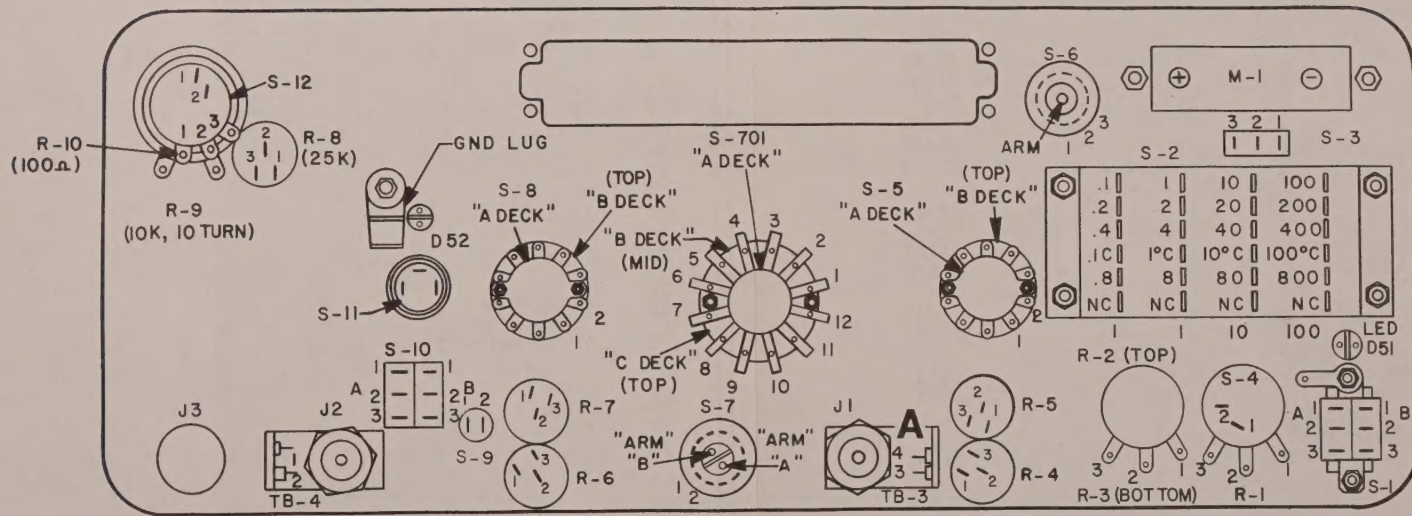
Fig. 10-1-1 Mechanical Breakdown Detail Views

009-0779-016



Table 10-1 NAV-401L COMPOSITE BREAKDOWN

| Index No. | Description                   | Circuit Designation | Index No. | Description                             | Circuit Designation |
|-----------|-------------------------------|---------------------|-----------|-----------------------------------------|---------------------|
| 1         | Front Panel Assembly.         |                     | 48        | Diode Protect Block                     |                     |
| 2         | Jack.                         | J2                  | 49        | Jack.                                   | J5                  |
| 3         | Bearing Zero Adjust.          | R8                  | 50        | Plug.                                   | P5                  |
| 4         | Glide Slope Centering Adjust. | R6                  | 51        | Jack.                                   | J4                  |
| 5         | Jack.                         | J1                  | 52        | Plug.                                   | P4                  |
| 6         | Localizer Centering Adjust.   | R4                  | 53        | Jack.                                   | J3                  |
| 7         | Monitor Meter                 | M1                  | 54        | Plug.                                   | P901                |
| 8         | Digital Display Assembly.     | Assy. 8             | 55        | Jack.                                   | J901                |
| 9         | Jack.                         | J601                | 56        | Phase Lock/Power Monitor Board Assembly | Assy. 4             |
| 10        | Plug.                         | P601                | 57        | Plug.                                   | P903                |
| 11        | Prescaler Assembly.           | Assy. 1             | 58        | Jack.                                   | J903                |
| 12        | Plug.                         | P1001               | 59        | 25 dB Pad                               |                     |
| 13        | Jack.                         | J1002               | 60        | Plug.                                   | P902                |
| 14        | Plug.                         | P1002               | 61        | Jack.                                   | J902                |
| 15        | Jack.                         | J1001               | 62        | Transmitter/Attenuator Assembly         |                     |
| 16        | Plug.                         | P1003               | 63        | Modulation Adjust                       | L1203               |
| 17        | Jack.                         | J1003               | 64        | Oscillator Tune Adjust.                 | L1201               |
| 18        | Trigger Adjust Pot.           | R1013               | 65        | Jack.                                   | J804                |
| 19        | Left Sideframe Assembly       |                     | 66        | Plug.                                   | P804                |
| 20        | 5 Volt Regulator Assembly     | Assy. 3             | 67        | Jack.                                   | J802                |
| 21        | Plug.                         | P1151               | 68        | Plug.                                   | P802                |
| 22        | Jack.                         | J1151               | 69        | Jack.                                   | J1201               |
| 23        | 5 Volt Trimpot Adjust         | R1158               | 70        | Plug.                                   | P1201               |
| 24        | Card Cage Assembly.           |                     | 71        | Plug.                                   | P801                |
| 25        | Card Edge Connector Jack.     | J101                | 72        | Jack.                                   | J801                |
| 26        | Card Edge Connector Jack.     | J201                | 73        | Glide Slope Power Adjust.               | R810                |
| 27        | Card Edge Connector Jack.     | J301                | 74        | Oscillator Assembly                     | Assy. 5             |
| 28        | Card Edge Connector Jack.     | J401                | 75        | Jack.                                   | J701                |
| 29        | Card Edge Connector Jack.     | J501                | 76        | Plug.                                   | P701                |
| 30        | Rear Panel Power Supply       | Assy. 2             | 77        | Jack.                                   | J703                |
| 31        | Rectifier Panel Assembly.     |                     | 78        | Plug.                                   | P703                |
| 32        | Jack.                         | J1101               |           |                                         |                     |
| 33        | Plug.                         | P1101               |           |                                         |                     |
| 34        | Plug.                         | P1104               |           |                                         |                     |
| 35        | Jack.                         | J1102               |           |                                         |                     |
| 36        | Jack.                         | J1104               |           |                                         |                     |
| 37        | Jack.                         | J1103               |           |                                         |                     |
| 38        | Fuse.                         | F1101               |           |                                         |                     |
| 39        | Buffer Amplifier Assembly     |                     |           |                                         |                     |
| 40        | Jack.                         | J1502               |           |                                         |                     |
| 41        | Plug.                         | P1502               |           |                                         |                     |
| 42        | Jack.                         | J1503               |           |                                         |                     |
| 43        | Plug.                         | P1504               |           |                                         |                     |
| 44        | Jack.                         | J1501               |           |                                         |                     |
| 45        | Plug.                         | P1501               |           |                                         |                     |
| 46        | Right Sideframe Assembly.     |                     |           |                                         |                     |
| 47        | Power Meter Zero Adjust       | R905                |           |                                         |                     |



Detail **A**

Fig. 10-2 Rear View of Front Panel



MP MASTER



MA30518